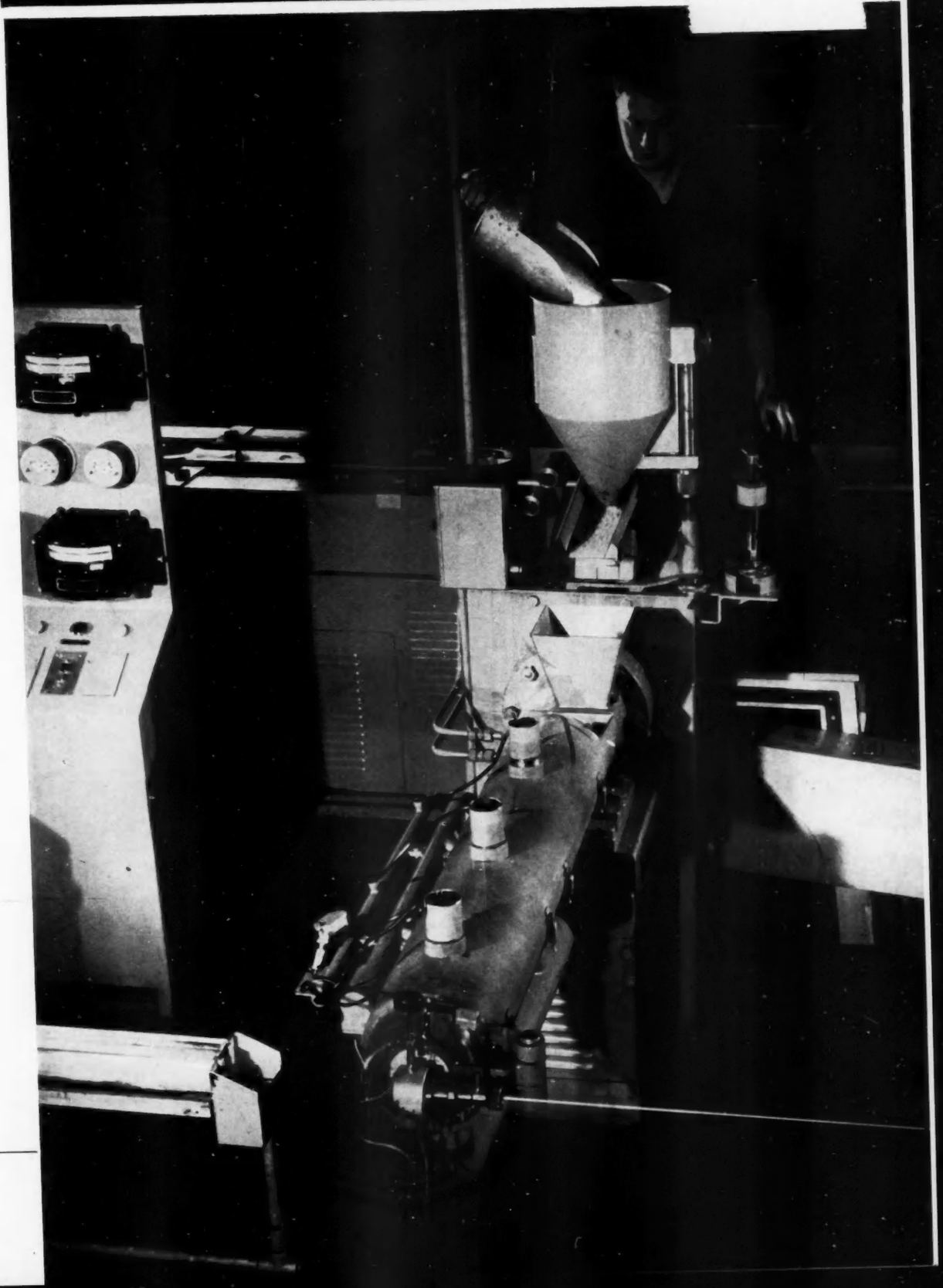
ENGINEERING

APR
ENGINEERING
LIBRARY



issue

APPLICATIONS OF
FOAMED GLASS

OLD ENGINES
COME TO LIFE

INJECTION RAMMING OF
RECIPROCATING ENGINES

SPACE PROBE

ISOLATING LOW
FREQUENCY VIBRATIONS

UNDERGROUND RAILWAY
WORK IN LONDON

PRICE
2/-

Choose from £3,000,000 Stocks of Machinery

GEORGE COHEN
SONS AND COMPANY LIMITED

BRITAIN'S LARGEST PLANT & MACHINERY MERCHANTS

MACHINE TOOLS, SHEET METAL MACHINERY, BOILERS, POWER PLANT, ELECTRICAL EQUIPMENT, HYDRAULIC PLANT, RUBBER AND PLASTICS MACHINERY, PROCESS PLANT, CONTRACTORS' PLANT, MOBILE CRANES, LIFTING AND MECHANICAL HANDLING EQUIPMENT, CONTRACTORS' TOOLS

THE 600 GROUP OF COMPANIES

WOOD LANE, LONDON, W.12
Tel: Shepherd's Bush 2070. *Grams: Omniplant, Telex, London.*

STANNINGLEY, NEAR LEEDS
Tel: Pudsey 2241. *Grams: Coborn, Leeds.*

SUNBEAM ROAD, LONDON, N.W.10
Tel: Elgar 7222/7.

And at: Kingsbury (Nr. Tamworth) · Manchester · Glasgow · Swansea · Newcastle · Belfast · Sheffield · Southampton · Bath

ENGINEERING

Vol. 187 No. 4854 20 March 1959 PUBLISHED EVERY FRIDAY

Contents

353 **Leading Article**
Light in the West

354 **Plain Words**

355 **Letters to the Editor**
Indian Institute of Technology
Mancur Spring Balance

356 **Obituary**
Frank Twyman F.R.S.
W. Cyril Williams

359 **Companies in the News**

Special Articles

360 Probing Space
380 Old Engines Come to Life

363 **In Parliament**

366 **Atomic Review**
Supercritical

368 **Automobile Engineering**
Road Research in the USA
Elusive Turbocar
Disc Brake Story
New Cars in Accidents
Quiet Holidays Abroad
Minx on Cobbles
BMC Win at Sestrière

376 **Book Reviews**
Industrial Law
Coal Mining Law
The Legal Aspects of Industry and Commerce
Heat Exchangers: Applications to Gas Turbines
Radiation Hazards and Protection

376 **New Books**

377 **Trade Publications**

377 **On the Shelf**

378 **Meetings and Papers**

384 **Engineering at Home**
Stereophonic Broadcasting

. . . . . .

354 **Management**
Weekly Survey

357 **Plant and Equipment**
Overhead Crane with Low Headroom
Universal Measuring Machine
Staff Locator
Flameproof Transformer
Repetition Marker
Transporter for Swamp Lands
Suction Drainer
Dial Gauges
Pneumatic Capstan Winch

364 **The Human Element**
365 An Overload Rating for Human Beings?

369 **Marketing**

370 **Research and Development**
Induction Ramming of Reciprocating Engines

372 **Design**
Anti-Vibration Mounting for Low Frequencies
Electric Cable to Resist Vibration
Higher Thrust for Orpheus
Retrieving Tangled Paratroopers
Trawler Weight Saved by Diesel Electric Propulsion
Large Transformer Bank for Sweden
Metal Sandwich Radar Aerials

379 **Metals and Materials**
Applications of Foamed Glass
Fungicidal Paint
Resin-Bonded Coatings of PTFE
Larger Sheets of Toughened Glass

381 **Operation and Maintenance**
Flexible Cargo Vessel in Use
Conway Rated for Service
Throw-away Air Filter

382 **Production**
Electric Surface Heating for Grease Tanks
Keeping the Worker in the Picture

383 **Construction**
Underground Railway Work in London
Maintenance Costs of Concrete Bridges

Light in the West

THERE is much more active co-operation in Western Europe than one is led to suppose by press reports of developments in trade and defence. In an article in this issue, the recent Zurich conference on "fitting the job to the worker" is reported by Mr. K. F. H. Murrell, whom readers will remember as the author of a series of articles on "data on human performance for engineering designers" in ENGINEERING two years ago. The conference attracted delegates from many countries. Two other developments—in business administration and among trade unions—emphasise the growing internationalism.

A new Institute of Business Administration under the patronage of the European Productivity Agency and the International Chamber of Commerce is to be opened in Paris next September. The responsibility for the preliminary work in the institute was taken by the Paris Chamber of Commerce, who provided the management and set up study committees. Although the institute is open to post-graduate students from all the West European countries including Britain, the Common Market will loom very large in the curriculum. Market research and sales techniques will be analysed from the point of view of a sales manager canvassing a new market. The effect of wider markets on industrial problems will be examined. The monetary, fiscal and banking policies of the different countries will be considered as the essential background against which industrial firms work. Other topics will be the case for a European financial market and the various laws and institutions directly affecting the policy of a firm operating in the different European countries.

Small groups of students will be given special research projects on which they will produce reports analysing the problems raised by European integration in industry, finance and commerce. The staff of the institute have been recruited from various European countries and the United States. In the first year there will be 80 students, increasing to 200 by the time the institute is in full swing. Students from any one country must not number more than a third of the total. The teaching will be in French, English and German. Students must speak one of these perfectly, a second very well, and understand the third. Much of the preparatory work of setting up the European Institute is now complete and the selection of students is taking place. An institute such as this which provides a bridge, not only between the universities, the engineering and commercial schools and industry, but between the nations as well, has a most useful and worthwhile task to perform.

Twenty years ago, trade union leaders would have laughed at the idea of workers' representatives in national or international negotiations being expected to have a knowledge not only of economic principles, but of job analysis, ergonomics, management techniques, developments in automation, and non-linear programming. Some of these terms were unknown 20 years ago, and no one man, however talented, can be expected to know all about all these things. The only solution for the trade unions, as for management, is to employ a research staff to brief them. In fact, a recent survey by the European Productivity Agency reveals the existence of over 50 such services in the 17 OEEC countries.

There have been two main reasons for this development. Between the wars the pace of engineering development was comparatively gentle, so trade union activities jogged along in the old familiar pattern. And slogans about the ownership of the means of production, distribution and exchange served instead of intellectual argument. Today the emergence of new techniques, new materials, new sources of energy have completely changed the situation. Rates of output have soared with new methods. Traditional problems have completely changed their character. The nature of production work is changing, reducing the sheer muscular fatigue and increasing the mental strain or nervous fatigue. Differentials for arduous work or special skill are giving place to responsibility payments.

The problem of the trade union leader today is that he has no book of precedents to help him. Every day brings its own problems, and they may be entirely new ones. But on top of these changes in routine activities, the trade unions have a whole lot of new functions. Radical changes in the economic and social structure of society and in industrial relations are taking place. Industry will have entirely new production conditions within the next decade, with the social problems of which it is not yet equipped to deal. It is all the more essential therefore that trade unions and management alike should employ men able to organise the data for solving these problems At the international level, the more co-operation there is between trade union research directors, the more seldom will yesterday's answers be given to the problems of today and tomorrow.

Cover Picture.—*Applying pvc insulation to a stranded conductor by extrusion. Precise temperature control by thermostats is essential to obtain uniform thickness of the pvc, which is cooled and hardened immediately in water.*

(*Nurnberg photograph for* ENGINEERING)

Plain Words

I always enjoy talking to experts: they have a new slant on almost everything. You may have been under the impression that the sun rose in the morning and set at night, but oh no, the expert tells us, we are spinning past it on some fantastic ball. Unbelievable, you say; unbelievable but true. Since Galileo we have continued to have our simple, innocent explanations knocked from under us, and today our frequency of disillusionment must be in the kilocycle range. I suppose it does us good; we are less credulous than we were; but nowadays it is our scepticism that endangers us.

As a result, our perspectives tend to be distorted, as if by the camera angles of some gigantic Orson Welles, and we find it virtually impossible to stand back and view our world with an objective eye. We either accept and worship; or we sneer. For this reason occasional contact with an expert is a salutary thing: his attention, concentrated on a tiny area, sees through the falseness to another half-truth just beyond. But an expert if too much immersed in his speciality, may be misled as to its place in life. The excitement of atomic energy work, for example, has sometimes led us to neglect equally important claims elsewhere.

In a sense this is the key dilemma in our working life. We are all experts of a kind, and our expertise creates a kind of self-importance. It is essential to see the importance of our own peculiar kind of work if we are to do it well; but to take our work or selves too seriously is to become blinkered if not depraved. How easy it is to see someone else's speciality as trivial, to feel a faint superiority when others argue heatedly over screw threads, the right temperature at which to keep tropical fish, the perforations on some foreign penny stamp, the thickness of heat-exchanger tube plates, or the jack of clubs that someone should have played in bridge. But then we return to our own grammar and equations, creating similar fictions of self-importance.

Sometimes we even counterfeit an enthusiasm we do not feel. Salesmen are often told that the first qualification for selling is confidence in the product. Can human beings really commit themselves body and soul to some arbitrary and perhaps quite trivial commodity they are called upon to sell? It is rather sad to watch a man faking an enthusiasm for, say, corsets or encyclopaedias, when the only real enthusiasm he feels is for his children.

I saw a film last Saturday about a man who took elephants seriously: he wanted to save them from extermination. At first I thought he must be crazy. But after a time I came to see his point of view. Elephants are really quite important.

CAPRICORN

Weekly Survey

Price of a Second Strip Mill

Details were announced last week of the way in which the new strip mill to be erected at Newport by Richard Thomas and Baldwins will be financed. They follow closely the precedent set in the case of Colville's new mill in Scotland. The Newport mill, which will have a capacity of 600,000 tons of finished strip mill products, is expected to cost about £100 million, of which the Government will lend up to £60 million over the next five years. The ingot steel capacity will be about 1 million tons and Richard Thomas and Baldwins plan to ship slabs from Newport to their existing strip mill at Ebbw Vale, which at present draws part of its slab requirements from Redbourne, Lincolnshire.

Initially, the Newport mill will be semi-continuous but it will be capable of being converted into a fully continuous mill with an output of 1 million tons per annum. The Colville mill, which will have a capacity of 500,000 tons per annum, will also be semi-continuous. The erection of two semi-continuous mills with a combined output of 1·1 million tons, which in a single plant would justify a fully continuous mill, is the price paid for the decision taken last November that for reasons of local employment the economic case for the erection of a single mill in South Wales should be over-ruled.

If the Newport mill is eventually expanded to fully automatic operation and the Colville mill is successful in attracting secondary industry to Scotland, this decision may justify itself. On the other hand, both the new mills will initially be producing at a higher cost than would a single mill and this may prove of particular importance in the immediate future when British industry will need to be fully competitive in order to meet the challenge from the European Common Market. Perhaps Scottish engineers will show that the compromise was justified?

More in Sorrow

Addressing the American Chamber of Commerce in London last week, Sir David Eccles the president of the Board of Trade, had some plain words to say about the recent signs of increased protectionism in America. This, he said, reduced the sense of economic co-operation between the Commonwealth and the United States. He gave a few concrete samples of what he meant. These included the recently announced United States quotas on imported lead and zinc and the restriction on oil imports; the rejection of the English Electric tender for the Arkansas Dam; the United States wool tariff which has cut United Kingdom exports of wool textiles to the United States by about one third; and finally the recent manoeuvrings at the international air navigation aid negotiations.

There have been some rather sophisticated reasons put forward for the United States Government's action on foreign bids. When English Electric recently failed to get the order for hydraulic turbines for Greers' Ferry in Arkansas, there were those who suggested that the United States Administration was playing a deep game which really favoured a liberal trade policy. The Arkansas contract was to go to Baldwin-Lima-Hamilton of Philadelphia, it was said, as a political feint. Having given in on this one, the Administration (so runs the argument) will be able to take a tougher line next time. We shall see.

Meanwhile, Sir David Eccles (whose name is associated now with advocacy of closer trade links between the Commonwealth and the United States, following his last visit to the United States) has aired a widespread and growing grievance in this country at United States economic policy. Industrialists here find it difficult to reconcile America's exhortation to its allies to become more efficient, cut costs and export more, while that country pursues a policy of pronounced protectionism which helps to keep European goods out of a major export market.

Vertical Production Lines?

At times considerations of the collective interest superimpose themselves on the narrower but often more practical self-interest of manufacturers. Factory building appears to be a case in point. A number of factors have contributed to a recent project on the practicability of building and operating multi-storey factories. The Department of Scientific and Industrial Research, through the Building Research Station working in co-operation with the Factory Building Research Committee, have produced a study designed to provide information on the operating costs of multi-storey factories. The committee was sponsored by the Midland Regional Board for Industry who, some four years ago, decided that there was a " a real need for more information to be made available to industry generally on this subject."

The first booklet in the Factory Building Series, entitled *Modern Multi-Storey Factories—a Discussion of their Design* (HMSO, 2*s* 6*d*) points out that there is a trend in modern industry for a considerable expansion in floor space per worker and that firms, when rebuilding, tend to transfer from multi-storey to single storey premises. A greater site area is therefore required for each factory and in many areas—particularly in the West Midlands, there are severe restrictions on industrial buildings.

The Building Research Station carried out the investigation, assisted by two research fellows employed by the committee, whose membership was representative of most interests concerned with factory buildings—architects, factory users, production engineers, constructional engineers, the building industry itself and some of the trade associations concerned with particular aspects of building. The Ministry of Labour and National Service Factory Inspectorate and the Ministry of Works are also represented. They have made a general study of the requirements and performance of buildings for general and light industries, excluding specialised and heavy industries such as steel and chemicals.

The complexity of the requirements of factory users and of modern building design and construction often makes it difficult for factory management to state clearly and precisely their own building requirements. This is particularly evident if the management is infrequently concerned with the erection of new buildings, and can afford comparatively little time to study alternative schemes. Among the subjects to be dealt with later in the series are lighting, structural loading, thermal insulation, electricity supply and distribution, fire protection, the use of colour, noise and structural frameworks.

Invest in South America

One of the more imposing of the white marble buildings pointed out to visitors to Washington is the headquarters of the Organisation of the American States. This classical edifice houses delegations and their secretariats, charged with furthering trading, cultural and political relations between the United States and the other American Republics. At times, such as the occasion of Mr. Nixon's visit to South America last year, it looks as though the organisation cannot be doing very much. At others it is clearly working overtime in the effort to describe the South American republics as the best places for the investment of Uncle Sam's dollars.

A recent issue of the *New York Times* was stiff

with full page advertisements from the South American states with messages it was hard to miss. Brazil's two pages stressed the advance towards industrialisation. The Volta Redonda steel mill was cited as an example of technical and financial co-operation. Since 1946 when production started, output of steel ingots has gone up from 470,000 metric tons to 804,056 metric tons. The fine new buildings of Brasilia, the new capital, are also shown as examples of Brazilian progress. Bolivia has obviously had its copy worked over by someone who has at least been to the United States. It sets out the prospects for oil and other minerals including uranium, and describes the highly favourable investment code. The fact that some mining companies have been nationalised is neatly glossed over. Apparently a Bolivian law of 1826 gave all mineral rights to the state. This, says the advertisement, was " long before the name of Marx had any significance." The companies in question were not in fact " socialised " but taken over to " correct injustice." The idea of friendly Bolivia, " penthouse of the Andes " is highlighted by some cunning pictures of Mr. Nixon being given a warm welcome during his visit there. Peru, on the other hand, modestly stated that it was proud of Alejandro Olemedo, the tennis player, and left it at that.

The Argentine, as would be expected, showed some very solid evidence of industrial progress, especially in the oil industry. Venezuela described a new steel plant whose low-shaft electric reduction furnaces will have a capacity of 1,200,000 metric tons. With so many outlets for industrial investment the Organisation of American States is likely to be very busy indeed over the next few years.

Coalescence

Coal stocks in Belgium, Germany and Britain have been very much in the news this year. How are the rest of the European countries faring and what does the picture for Europe as a whole look like? These questions are answered in the *Quarterly Bulletin of Coal Statistics for Europe* recently published by the Economic Commission for Europe.

For Europe as a whole hard coal production in 1958 at 616 million metric tons was 6 million tons below the 1957 level. At the same time stocks of unsold coal continued to pile up at the pitheads. By the end of December, Belgium had 6·9 million tons, France 7·6 million tons, Holland 800,000 tons, West Germany 8·6 million tons, the Saar 900,000 tons and Britain 20 million tons. In Poland and the USSR stocks were at normal levels, of 650,000 tons and 7·5 million tons respectively. The main reduction in output occurred in Belgium, down 2·1 million tons, and Britain, down 7·8 million tons. In Western Germany, although short-time working was introduced, the drop in output was small because of increased productivity. Imports of hard coal by Western European countries totalled 69 million tons in 1958, compared with 89 million tons in 1957. Imports from the USA amounted to 31 million tons as compared with 45 million tons in the previous year. So far as movements of coal within Europe are concerned imports from Belgium fell by 1·6 million tons, from France by half a million tons and from West Germany by 1·8 million tons. Exports from the United Kingdom at 3·9 million tons were down by 2·9 million tons. West Germany was the largest hard-coal importer with 16 million tons compared with 21 million tons in 1957. France imported 15 million tons and Italy 9 million tons. Britain reduced imports of hard coal from 2·9 million tons to 700,000 tons.

It is clear from the report that the coal industry all over Europe is running into difficulties. The hardest hit countries are those that were short of coal a few years ago and made long-term contracts to buy from abroad, especially from the United States. The aim of fuel policies everywhere at the moment seems to be to cut coal production, cut coal imports, cut oil imports and go slow on the development of nuclear power stations. Not the brightest of prospects for a technological age.

Introverted Six

The Belgian miners' strike has drawn attention to a problem that has been getting steadily worse ever since the European Coal and Steel Community was set up in 1952. The cause of the trouble is that Belgium has too many small companies operating its mines. The High Authority has paid a subsidy to the Charbonnage Belge, the coal-owners association, to enable them to rationalise the industry by closing down the uneconomic pits in the Borinage area, of which Mons is the centre. Prosperity has, however, prevented the scheme operating; so long as there was a seller's market for coal every ton of coal that could be brought up could be sold. When the recession reached Western Europe and the pithead stocks began to build up, it was too late to do anything about the basic problems of the industry.

What has happened in recent weeks gives a good illustration of the problems of supranational bodies. The Belgians are anxious to have help from the High Authority in disposing of their stocks. This has been forthcoming in the form of a grant of about £8,000 towards the cost of coal stocking. The High Authority has the difficult choice of declaring a " manifest " crisis which would involve setting output quotas for all ESCC coalfields, or of restricting imports of coal from outside.

This is the first big test of whether the Six will be inward looking or outward looking in their dealings with third countries. What has happened does not auger too well for the prospects of the rest of Europe in trading with the Six as the European Economic Community. The High Authority has not been able to persuade the French or German governments that a comprehensive coal policy for the Six is now needed. Instead, imports from Britain, and more particularly the USA, will be cut, and the Belgian coal position will be shored up by High Authority funds to help find new jobs for displaced miners. As most of the men affected are Italians anyhow, the Belgian government's insistence that supranational action is needed is understandable. It certainly seems to have paid off.

Trust Europa

The development of the unit trust movement, which has been such a feature of the British scene over the past twelve months, has spread to the Continent. Two different kinds of trust are involved. The first type has only shares in companies in the Six in its portfolio. The other is less selective and includes all OEEC countries including some British firms.

All these trusts have invented names for themselves that emphasise their European connections. Eurunion, the main Six nation trust, has investments distributed through the member countries in the following proportions: Germany 23 per cent, Belgium 10, France 21, Italy 14, Luxembourg 4, and Holland 16 per cent. In addition the trust has 10 per cent of its assets in liquid form. The main industries represented are electrical engineering, metal working, chemicals and oil. This trust will be administered by a management company known as Sogim, based in Luxembourg. The sponsors of the trust include the Berliner Handelsgesellschaft, Credit Commercial de France, Compagnie Financiere of Belgium, Compagnie d'Outremer pou l'Industrie et la Finance for Holland, and Messrs. Pierson Heldring and Pierson for Italy. Eurunion is the first European unit trust to be put on sale simultaneously in the Six Common Market countries.

Another trust making an offer of shares is Eurit. In this case the portfolio is not confined to the Six but includes shares in companies from Britain, Denmark, Sweden, Norway and Austria. This trust has been promoted by a group of Swiss interests but its backers also include South African and American interests. Europa, one of the first German unit trusts specialising in industrial securities of the Six, was launched in January. A Swiss trust, Europa Valor, which includes some British shares, appeared in February. In the USA a new trust, Eurofund, has been started to invest in equities in the Six countries.

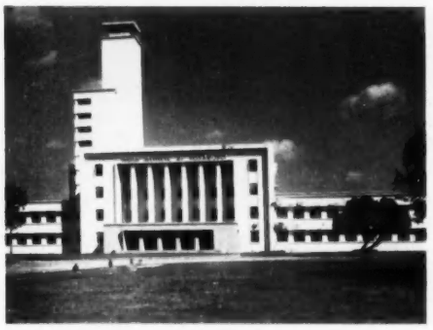
The important thing about these Euro-trusts is that they indicate the development of a European capital market. This is something that has not existed since 1939. Where Britain will stand in this movement is not yet clear. The City has always been an international market with particular interests in the Commonwealth and America. Whether British investors will now turn from Wall Street to Zurich and Frankfurt remains to be seen.

Letters to the Editor

INDIAN INSTITUTE OF TECHNOLOGY

SIR, I have read with interest the article entitled " Scientific and Industrial Research in India," on page 300 of your issue of 6 March. The article includes, among others, an illustration that is captioned " The new building of the Indian Institute of Technology." In fact, that illustration shows the old building where the Indian Institute of Technology was inaugurated in 1951. The more modern new building was completed in 1956.

I graduated from the Institute in 1956 and the



attached reproduction is from a photograph of the new building taken for me by a friend to illustrate an article on the Indian Institute of Technology that I was writing.

Yours faithfully,
R. N. MAGO.

c/o J. Stone and Company Limited,
Arklow Road, London, SE14.
8 March, 1959.

MANCUR SPRING BALANCE

SIR, There has recently come into my possession a " Mancur " type of spring balance. It takes the form of a C spring and may be suspended from one of two rings, according to which of the two ranges of weighing is being used; the lower range reads from 1 to 45 lb, and the higher from 20 to 300 lb. As far as I can trace it has been in our family for over 80 years and the remarkable point is that it still reads correctly on the lower range and also on the higher range up to 100 lb, but, so far, I have not had the facility to test it to its limit.

I should be interested to know if any of your readers can say how this balance came to be known as the " Mancur " balance, or whether this is the name of the inventor. Incidentally, one of the brass scales bears a trade mark in the form of a square and compass.

Yours faithfully,
J. F. PERRIN.

6 Cavendish Avenue,
Welling, Kent.
12 March, 1959.

Obituary

FRANK TWYMAN F.R.S. *Scientific Instruments*

The death of Mr. Frank Twyman on 6 March has deprived the country of one who played a leading part in applying scientific knowledge to industrial uses.

Born in Canterbury in 1876, he was the seventh child of a family of nine and commenced his education at Simon Langton School in the same city. His technical training followed, first at Finsbury Technical College, where his tutors included the celebrated Silvanus P. Thompson, Perry and Meldola, and then, as a Siemens Scholar, at the Central Technical College.

From a very early age, he displayed a keen observation, a prodigious memory and a passion for subjecting scientific statements to experimental tests. On leaving college, he was employed for a time by the Fowler Waring Cables Company, sub-contractors to the old National Telephone Company, on testing telephone cables. The job involved night work which he found unduly tiring and it was with pleasure that he accepted a post offered him by Otto Hilger, who, following the death of his brother Adam Hilger, had been carrying on the firm of that name, in the small but renowned scientific workshop in Stanhope Street, London. Twyman was then only 22 and when, on the death of Otto Hilger in 1902, Twyman succeeded him as manager, he was still but 26 years of age. Two years later, in 1904, the firm became a limited company and Twyman was appointed managing director. He retained this position until 1946. In 1948, the firm amalgamated with another leading firm of scientific instrument makers, E. R. Watts and Son, to become Hilger and Watts Limited. Twyman remained a director of the new firm until 1952, when, at the age of 76, he was appointed scientific adviser to the organisation.

At the commencement of his association with Adam Hilgers, he undertook all testing of optical work and the adjustment of the firm's scientific products. He made the complete drawings for all instruments until 1910 and was responsible for introducing into the firm the use of proof-plates for the testing of optical surfaces. Later, he developed the testing of optical components by means of interferometers, and Twyman-Green interferometers have been used for many years in the making of high-quality optical products. In this connection, it is of interest that a complete series of these interferometers was purchased in 1929 by the Carl Zeiss organisation.

His pioneer achievements in the field of spectrochemical analysis probably formed his main contribution to practical scientific progress, and it is for these that he will best be remembered. Twyman had designed and produced the wavelength spectrometer in 1904, an instrument which became very widely used by chemists and physicists for research and teaching, but its use in metallurgy was neglected, despite the fact that Kirschhoff and Bunsen had used the spectrograph for the analysis of metals as far back as 1860. This lead Twyman to design the fixed-adjustment quartz spectrograph, which made use of ultra-violet as well as visible light: this was a great advancement, since most of the spectral lines important for the analysis of metals are contained in the ultra-violet region. A larger instrument suitable for the analysis of steel was also developed. It was not, however, until similar instruments began to be made by Zeiss, and Bausch and Lomb, that Twyman's products gained the publicity and appreciation that they deserved. He gained further successes with X-ray instruments designed for the study of X-ray spectra and the structure of crystals.

Twyman was elected a Fellow of the Royal Society in 1924. As to other honours, it may be mentioned that these included the John Price Weatherill medal of the Franklin Institute, the Duddell medal of the Physical Society, and the gold medal of the Society of Applied Spectroscopists, of the United States. His wide experience in the field of optical instrument production was well brought out in his noteworthy book *Prism and Lens Making*.

W. CYRIL WILLIAMS *Export of Steam Locomotives*

The locomotive industry has lost a dynamic personality with the death on 5 March of Mr. W. Cyril Williams. He was 69.

Few men had such a wide personal knowledge of the railways of the world, or of railway officers throughout the world. From 1923 until a few years ago, he was constantly visiting many overseas railways, and his advocacy of the Beyer-Garratt locomotive—with its high power

but low axle loading—expanded his company's export trade.

William Cyril Williams was born in 1889 and educated in London. He commenced his railway work in 1906 with an apprenticeship to the Natal Government Railways where his training, apart from the general workshop course, included running shed, signal department, footplate and drawing office experience. He attended the Durban Technical Institute and obtained the Abe Bailey Scholarship in 1909, the James Brown Exhibition in 1910 and the institute Scholarship in 1911. For a short period in 1912 he was a lecturer at the Institute. In 1913 Williams was appointed a junior engineer to the chief superintendent of motive power at Johannesburg.

During the First World War he was commissioned in the South African Engineer Corps. He served throughout the campaign in German South West Africa, with the rank of Captain in the Railway Regiment. During this time he was locomotive foreman at Usakos, and later was assistant superintendent (mechanical). Subsequently he was posted to France in the Royal Engineers, and was promoted to Army Locomotive Superintendent.

In 1919 Williams went to the United States and Canada, on behalf of the South African Railways, where he was responsible for the inspection of locomotives, wagons and other railway equipment. After one year he returned to London and acted for a short time as advisory engineer to the South African Railways in London, and eventually returned to duty in South Africa on the staff of the assistant general manager in Durban. Up to 1923 he was largely engaged on special engineering test duties, in particular with locomotive performance, and he was associated with the early tests of the Garratt articulated locomotive.

In 1923 Williams joined Beyer Peacock and Company Limited, and came to this country as their London representative. He soon became an enthusiastic advocate of the advantages to be obtained by the use of the Beyer-Garratt, probably the most successful type of articulated locomotive. Indeed, he was largely responsible for the successful application and use by so many railways throughout the world of this type of locomotive. Subsequently, in 1945, he was elected to the board as sales director of the company.

During the Second World War his wide experience and knowledge of overseas railways were freely drawn upon by the War Office and the Ministry of Supply, and he actively participated in the work of his company on important armament and locomotive production for the war effort.

Williams was President of the Institution of Locomotive Engineers in 1949-50, an associate member of the Institution of Civil Engineers and a member of the Institution of Mechanical Engineers.

TRANSALPINE PIPELINE

From Genoa to Switzerland and Germany

Several oil pipelines to the centre of Europe from the north already exist. Now a new line is projected from the south. This will start from Genoa and diverge in three directions: to oil refineries in Northern Italy; to a new 2 million ton refinery in Western Switzerland; and a continuation to Munich where a 5 million ton refinery is to be constructed.

The line in North Italy will have a diameter of 28 in and its ultimate capacity will be 15 million tons a year. It will probably run by Pavia and Milan. The branch to Switzerland would go by way of the Saint Bernard road tunnel now under construction. The distance from Genoa to Aigle, the probable site of the refinery is just over 200 miles. The sections in Switzerland and Italy, and the Aigle refinery are joint projects in which the partners are the Société Financière Italo-Suisse of Geneva, and ENI, the Italian state-controlled oil monopoly. The extension to Munich is at present planned as an ENI project. These new developments are further evidence of the determination of ENI, under the dynamic Signor Enrico Mattei, to extend its interest outside Italy. Italo-Suisse is a mainly Swiss-owned group which already has interests in Italian electricity and steel, and owns part of the oil-port area of Genoa.

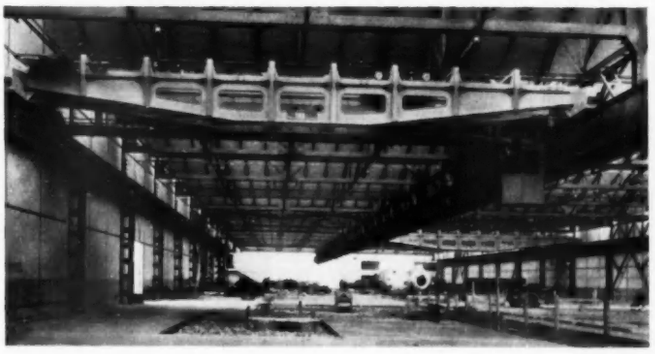
The manpower, steel and equipment required for the pipeline will be mainly Italian. Permission has already been given for the laying of the pipeline in Italy and work is expected to start soon. Considerable pumping capacity will be needed. At the moment it would seem that the scheme is ambitious in relation to the refining capacity of Northern Italy, and the oil requirements of Switzerland. However, in view of the eventual needs of both areas the promoters no doubt feel that they stand a good chance of profiting from their initiative and foresight.

Plant and Equipment

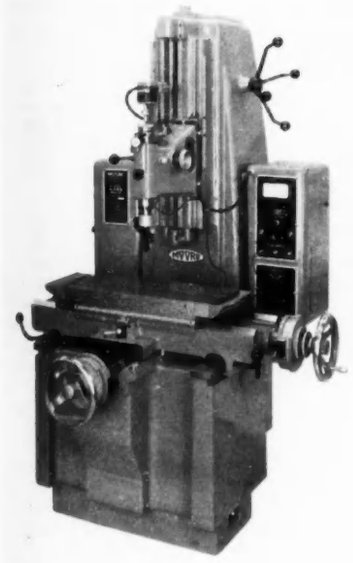
OVERHEAD CRANE WITH LOW HEADROOM

The Reel overhead travelling crane shown in the accompanying illustration differs from common pratice in that the side members are Vierendeel girders; similar arrangements across the upper chord provide the lateral stiffness, and there are, in consequence, no outrigger frames. Headroom is kept low by using a crab which runs inside the bridge, underslung from the channel booms. Sizes are available up to 40 tons in capacity and with a 100 ft span and will probably be increased to 100 tons.

Electrical controls are used, though the system can be varied to suit the customer. Cranes are available with cabs, or for floor operation from hanging push buttons in which case a 24 V control circuit can be used. Noise has been reduced to the minimum; the drive from the motor to the long travel shaft is through belts, and the shape of the end cases, which enclose the wheels, also helps to reduce external noise. The box section end frames are welded to the main structure which itself is welded throughout. The Reel crane is being made in this country, under licence, by the British Industrial Engineering Company (Staffs) Limited, Tividale, Tipton, Staffs.



The Ree crane uses Vierendeel girders and an underslung crab to reduce headroom.



UNIVERSAL MEASURING MACHINE

As a result of some special orders for a jig boring machine to be supplied without its spindle and drive motors with the object of using it solely for inspection purposes, the Moore Special Tool Company of Bridgeport, Connecticut, USA, whose agents in this country are the Catmur Machine Tool Corporation Limited, 103 Lancaster Road, Ladbroke Grove, W11, have now produced a high precision universal measuring machine based on the jig borer design.

The machine is intended for fairly large components and has a table size of 11 in by 24 in with 18 in of longitudinal movement and 11 in of cross travel. It is shown in the accompanying illustration. The table movements are very accurate and the spindle will rotate with a trueness of 0·000005 in. The greatest error in any inch in the longitudinal and cross travel is 0·000015 in.

This machine can be supplied with hand or motorised leadscrews, the latter having three traverse speeds. Measurements can be carried out by means of a universal microscope or an amplifying gauge head as shown in the illustration. The gauge head indicates on the panel at the right of the machine, the scale being normally divided into 0·00001 in divisions and 0·0001 in divisions, the change being made by a selector switch. Plug-in recorders are also available either of the rectangular or polar chart type. As an accessory, a rotary table is available with a guaranteed accuracy within two seconds of arc over the full revolution.

This universal measuring machine is based on a precision jig borer.

STAFF LOCATOR

The Nira Tele-Tracer system for staff location consists of a pocket receiver weighing 3¼ oz operating in conjunction with a central station and a closed circuit transmitting loop. A Dutch development, it is being marketed in this country by Cass Electronics Limited, White Hart Yard, Guildford Street, Chertsey, Surrey.

The receivers are powered by small accumulators which are automatically recharged when the receiver is returned to its storage rack, placed at the entrance to the building in which the system operates. When a receiver is in the rack the call operator gets an automatic signal that that person is not in the building.

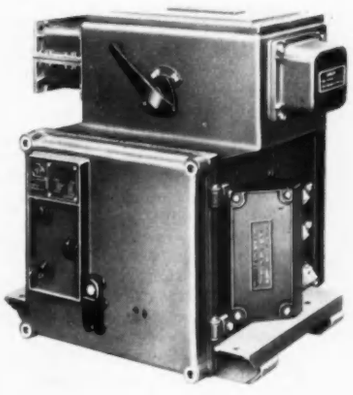
There are two types, one gives an intermittent buzz only, while the other has a light signal in addition to the buzz. The call box has 12 buttons and is suitable for placing next to the telephone operator. The combination of buttons allows for 360 different calls to be made. "Senior" installations are available for up to 9, 45 or 360 persons and there is a "Junior" simplified version suitable for calling nine persons. In this, the operating station is in one unit consisting of the selection keys and the electronics system for feeding the loop; it is limited to areas under 25,000 square yards.

FLAMEPROOF TRANSFORMER

The most recent addition to the range of flameproof equipment built by the Belmos Company Limited, Bellshill, Lanarkshire, is a lighting transformer unit designed to NCB specifications.

The unit can supply three lighting circuits with a maximum capacity of 13 A each, or one circuit of 40 A. By means of a series/parallel link board an output of either 115 V or 230 V can be selected; these outputs may be varied to give 125 and 250 V respectively. Earth leakage protection is incorporated by means of a miniature circuit breaker. The single-phase transformer has a continuous rating of 4·5 kVA and has its primary winding fitted with variable tappings on the incoming side to suit supply volages between 400 and 650 V.

The housing consists of a welded steel case divided horizontally into two flameproof compartments. In the upper are the 300 A throughgoing bus-bars and the two-pole isolating switch, and in the lower are the transformer and its protective equipment which are mounted on a chassis that can be withdrawn on slide rails. All electrical connections between the chassis and the enclosure are made by spring-loaded butt contacts.



Flameproof lighting transformer to National Coal Board specifications.

Continuing **Plant and Equipment**

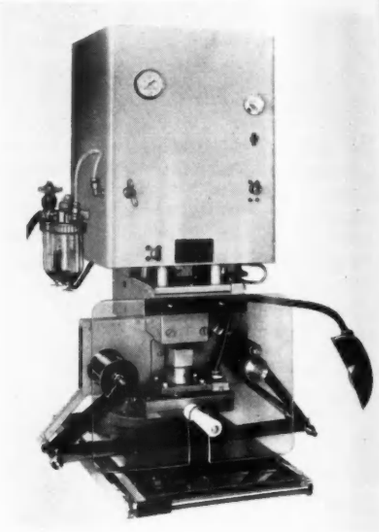
REPETITION MARKER

A pneumatically operated hot press marking machine has been added to the models made by Phillips Brothers and Ellis Limited, 11-13 Charterhouse Buildings, off Goswell Road, London, EC1. It is suitable for repetition marking, identifying or decorating a wide range of materials, including plastics of all types, cloth, silk, rubber, wood, leather, board and paper.

The mark is obtained by the use of heat and pressure which transfers pigment from a specially prepared paper foil on to the surface of the article. An indelible mark is obtained which moulds with the material and which can be produced in a wide variety of colours. The machine is fully automatic, in that once set up for any given job it will always repeat the same conditions of temperature, pressure and dwell. No specialised labour is therefore required, and a very high output rate may be easily maintained.

The advantages of pneumatic operation are that variations in the thickness of materials are automatically compensated for, and that the machine requires the very minimum of maintenance, as there is no complicated gearing or delicate parts. The machine is operated by foot control, but for incorporation in production lines it is also supplied with an automatic tripping mechanism which actuates the machine at given intervals.

Both pressure and imprint time are easily adjusted and the machine has automatic compensation for variations in thickness up to 1½ in; hand adjustment gives a full coverage from paper thickness up to 18 in. Some 40 different shades of marking foil are available. The machine stands 50 in high and measures 35 in long by 19 in wide. A supply of air at 80 lb per sq. in is required together with electricity for heating.



Pneumatically operated marking press.

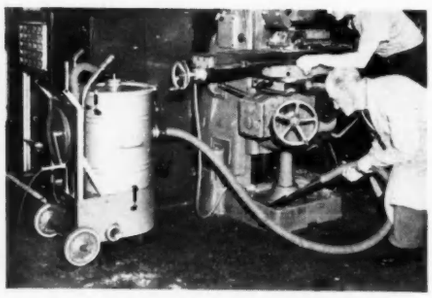
TRANSPORTER FOR SWAMP LANDS

A new version of a large tractor has been produced by Albion Motors Limited (a member of the Leyland Group) for the Shell-BP Petroleum Development Company of Nigeria Limited. The machine, known as the Albion-Cuthbertson "Water Buffalo," of which the earlier model was described in ENGINEERING, 7 Feb., 1958, is designed to transport heavy drilling equipment and materials into the heart of the Niger Delta swamp lands. It will be powered by a Leyland 150 b.h.p. direct injection diesel engine with a torque as high as 450 lb-ft. Its special construction ensures that it will penetrate areas impossible to vehicles a fraction of its weight. The tread loading is about one quarter of that of a man, exerting a ground pressure of 1½ to 2 lb per sq. in only.

The "Water Buffalo" will be shipped with two amphibious slipes, or trailers, one a 28 tonner the other a 10 tonner. It will haul the 10 ton slipe laden with smaller equipment, tools, and reels of cable, which will "run-out" to form a ropeway across the swamps to help the tractor negotiate the worst surfaces when hauling the larger slipe laden with 28 tons of machinery. A powerful capstan winch, mounted on the front of the deck of the machine, will pick up the cable and haul the amphibious train over the most difficult stretches. The speed of the vehicle's tracks is always synchronised with that of the winch, giving maximum tractive effort. The flat top deck of the vehicle will also be equipped at the front with a bulldozer blade operated hydraulically, an A-frame at the rear for use as a crane and an oilfield type winch with a line pull of 70,000 lb.

The tractor is also fitted with an extension to the body sides to make it amphibious, for use in deep water. This extension is readily removable when it is not required. The slipe trailers also have sufficient freeboard to enable them to float fully-laden in deep water.

SUCTION DRAINER



A suction drainer designed particularly for emptying machine tool sumps of swarf, grindings, sludge and cutting oil has been developed and is being made by Progress (Universal) Limited, 590-594 Wandsworth Road, London, SW8.

The equipment consists of a suction pump and a 20 gallon capacity tank mounted on a rubber tyred carriage and fitted with 10 ft of reinforced 1½ in diameter flexible rubber hose. A range of rubber nozzles is available to reach into awkward corners. Extra capacity can be obtained by having several drums in series. Emptying the liquid from the tank is effected by a large bore tap, and the tank itself can be removed from the carriage to empty the solid matter. The pump is driven by a ¾ h.p. capacitor motor and its impeller is protected against the entry of liquid by a valve in the tank. A cable winder is mounted on the back of the carriage with a handle so that the three-core supply cable does not have to be moved by hand.

The air displacement of the pump is 140 cu. ft per minute; water lift 36 in; the overall dimensions of the equipment are 3 ft 4 in high, 2 ft 3 in long and 18 in wide, and it weighs approximately 140 lb. Apart from emptying sumps it can also be used for the removal of oil and sludge from floors and for drying them after scrubbing by the addition of an extension tube and squeegee nozzle.

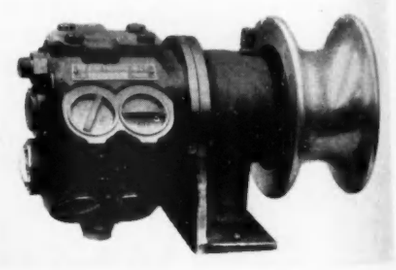
DIAL GAUGES

Now available in this country, from Rubert and Company Limited, Demmings Road, Cheadle, Cheshire, are the high-precision dial gauges made by Junghans. These have a jewelled movement and can be calibrated in either 0·0001 in or 0·0005 in divisions. The Microcontac gauge is fitted with electrical contacts to indicate high and low dimensions and can be connected to a display box having coloured lights to show whether the part being checked is above or below the required tolerance. The contacts are separately adjustable. A variety of stands is available, ranging from a suction model for checking a single dimension to multi-head models which can gauge up to 20 dimensions simultaneously.

PNEUMATIC CAPSTAN WINCH

A portable pneumatic capstan winch capable of lifting 300 lb has been designed and developed by Globe Pneumatic Engineering Company Limited, Ashton Road, Harold Hill, Romdorf, Essex. A 4-cylinder V-motor, developing a high starting torque, powers the winch unit. With a working pressure of 80 lb per sq. in at 40 cu. ft of free air per min the winch has a maximum lifting speed of 80 ft per min.

The complete unit, with a machined aluminium capstan head weighs 35 lb. Overloading or stalling cannot damage the unit, it is flameproof and unaffected by corrosive or damp atmospheres. Easily operated by foot or hand valve, as required, the direction of rotation of the winch can be changed by reversing the air flow.



Portable pneumatic capstan winch for 300 lb lift.

Companies in the News

Iron Founders

The output of iron castings continues to fall and employment in foundries has been further reduced. The statistics in respect of 1958, recently published by the Joint Iron Council, show that at the end of December the number employed was 125,800, representing a reduction in the labour force of 2 per cent from the end of September level, and of 8 per cent in the full year.

Output for the engineering industry, including large consumers, such as the makers of machine tools, textile machines, electrical machinery and shipbuilders, was 11·4 per cent lower than in 1957: it amounted to 1,170,100 tons out of a total production of 3,403,200 tons. The most marked fall in demand was in respect of ingot moulds for the steel industry, which showed a decline of 18·5 per cent. Castings for building and domestic trades were down by 11·6 per cent. The motor industry was the only consuming industry to increase consumption during 1958 by 6·0 per cent, although demand also declined from that quarter during the last three months of the year. The overall decline in demand during that period was one of 15·3 per cent, mainly influenced by a fall of nearly 20 per cent in engineering demand and of over 29 per cent in demand for ingot moulds for the steel industry.

The Council do not attempt to forecast any changes in the pattern of demand, nor do they give an indications of developments during the past two months. Their only general comment is that "the continued trading weaknesses in many important industries which constitute a major proportion of the market for iron castings largely explains the further reduction in iron-founding production.

Lloyd's Reporting

Discussions with representatives of the Register of Shipping of the USSR and growing concern with developments in the field of nuclear energy are two of the important topics discussed in the annual report of Lloyd's Register of Shipping. Technical recovery of the Register's activities are given under various headings, including marine engineering, refrigeration and metals and plastics. A working party consisting of representatives from the American Bureau of Shipping, the Bureau Veritas, Germanischer Lloyd, Nippon Kaiji Kyokai, Norske Veritas, Registro Italiano and Lloyd's Register studied the 22 different kinds of steel at present approved for ship construction in the rules of the seven classification societies and put forward a detailed formula reducing the number of grades to five. The working party's proposals have been accepted in principle by a steel panel of the society's technical committee and talks will continue "until the maximum degree of uniformity is achieved." The Register comments that "even a modified agreement will undoubtedly bring great benefit to the shipbuilding and steel-making industries."

Two representatives of the Register of Shipping of the USSR, at their request, spent some time in London on an exploratory mission to see whether any common ground existed on which could be built up an organisation of mutual benefit to both parties. No agreement was concluded, but Mr. Kenneth R. Pelly, chairman of the Register, comments that the conversations which took place "did much to help towards a closer understanding between us."

On the subject of nuclear propulsion, the report notes further progress, particularly in the United States and the USSR. Research is proceeding in this country and the society have been entrusted with survey of the prototype propulsion unit for a land-based submarine project which is intended for experimental and development purposes and is to be built at Dounreay for the British Admiralty. In the view of the Society, if progress is to be made in the United Kingdom with a nuclear surface ship "a decision on the type of reactor for this ship must be made on the basis of present knowledge and experience of land-based reactors. Lack of actual operating experience of a reactor under marine conditions may well handicap future commercial development." The American nuclear ship Savannah is now being built and its commissioning, in about two years time, will demonstrate the practical feasibility of nuclear propulsion for surface ships and whether it can be a commercial proposition. "She postulates questions of international significance," states the report, "such as safety arrangements in design and operation, the acceptance of nuclear ships in the ports of the world, disposal of waste products and insurance matters affecting owners' and governmental liability."

Steel Shuttlecock

A spirited plea that politicians should leave the steel industry alone was made by Lord Dudley G. Gordon, chairman of Hadfields Limited, in his annual statement to shareholders. The uncertainty which must affect the industry in what is likely to be an election year is, in Lord Gordon's view, a most unfortunate adverse factor in its future prospects. Should there be a change of Government there could well be a major struggle despite "the well established principle that industry should not get involved in politics." Along with other leaders in the iron and steel industry, Lord Gordon considers it is the duty of those who run the industry to do what they can to resist a change "which would not be in the best interests of its shareholders, employees and customers." It is in no-one's interests that steel should become a shuttlecock of politics.

Hadfields are now a sizeable group of companies, comprising the Millspaugh Group. Their activities include the manufacture of special steels, forgings, castings, and a range of special fabrications such as furnace bodies and refractory towers for the chemical industry. Results during the year ended at 27 September, 1958, reflect the difficult trading conditions experienced in most departments. Net trading profit (before tax, but after depreciation) totalled £609,000 compared with £1·13 million for the previous year. The major factor in this reduction of profits has been a marked fall in orders, which has revealed weaknesses in the sales organisation of the group and certain basic changes have been made. "The improvement of our sales organisation," said Lord Gordon, "has been under very close consideration and as a result of careful investigations which have been made, we are satisfied that our sales effort can be improved."

Looking ahead Lord Gordon anticipates an improvement in demand. He quotes "competent authorities" who expect a definite improvement during the summer months of the present year and appears to share their view.

Mather and Platt take Steps

A considerable reduction in profit margins has been experienced by Mather and Platt during 1958 (year ending last 31 December). Turnover was substantially the same as in 1957 but consolidated trading profits fell to £1·44 million, some £600,000 less than the previous year when the £2 million mark was passed for the first time in the company's history.

Mr. L. E. Mather, the company's chairman, told shareholders that the world recession in textiles has been an important factor in the company's overall results. "We have attained," he said, "only a portion of our sales of textile finishing machinery." They have also suffered from the imposition of import restrictions, particularly in the case of India which has been for many years their best export customer. They are taking the course imposed on so many of India's British engineering suppliers and setting up a subsidiary company in India for the manufacture of certain parts of textile machines and also developing facilities for further manufacture in that country of some of their other products.

Mather and Platt have been successful with further contracts with the Soviet Union during the year—for food processing machinery—and the manufacture of plant for tyre factory contracts helped to keep up turnover. On the whole, however, Mather and Platt are faced with the problem of replacing much of their turn-over in textile finishing machines with other products.

Company of Companies

The progress of Norcros Limited over the past three years has attracted a great deal of attention, mainly by the outstanding results they have obtained. Formed as an industrial holding company in June, 1956, Norcros now have twelve subsidiaries. Fixed assets at the end of their last financial year (30 June) totalled £891,000 and net trading profit before tax £680,000. The two companies acquired this year—Temperature Limited and Hygena Limited—will raise fixed assets to £1·15 million and the profit figure to about £1 million in a full year. Such results, on the basis of a share capital of £850,000 (365,000 £1 preference shares and 2,334,000 5*s* ordinary shares), suggest that the companies purchased by the group are much above average in profitability.

Norcros state their aims in a foreword to the annual report, and explain how they select companies for purchase. Subsidiary companies are "wholly owned" and have been selected "from a wide cross-section of British industry." There is no concentration on any particular field, not even manufacturing. Prior to their incorporation within the group they were controlled and managed by their founders or their families. The objects of the group are firstly "to enable the public to invest in some of the soundest and most progressive industrial companies of a limited size, which up to the present have been entirely in private hands," and secondly, "to provide a means by which the private owners of these companies can avoid the destruction of their life's work by penal taxation and death duties, and yet retain an active interest by continuing to manage their companies, and by investment in their parent company of which they become an active, participating member." Care is taken when considering new acquisitions that management is progressive and assured for the future, that personalities and business outlooks are similar to existing members of the group, and that relations with staff and workpeople have always been happy. Lastly, great importance is attached to past profit achievements, encouraging growth possibilities, and financial self-sufficiency.

Machinery Merchants Get Together

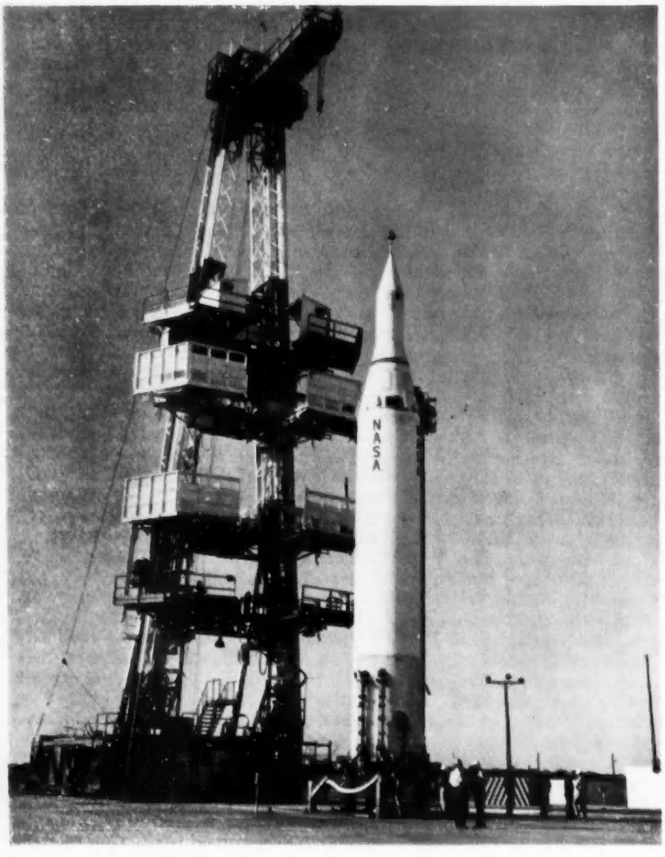
Machinery merchants are meeting later this month to discuss the future policy and development of their new association. A proposal has been tabled to change its name from the Association of British Machinery Merchants to the Association of Industrial Machinery Merchants. "to avoid any possible conflict with existing organisations with similar sounding names." Liability of members will be limited by guarantee.

A strong nucleus of machinery merchants are already in support of the organisation. The committee will initially concentrate on recruitment to secure the maximum possible representation and thus enable them to act in the future as speaking for the majority of the recognised machinery merchant firms in the country in any matters deemed necessary. One of the main objects is to achieve status and strength as a negotiating body. In general it will look after its members' interests. This in itself, in the present context of the Restrictive Practices Act, will provide a most interesting lead for existing trade associations.

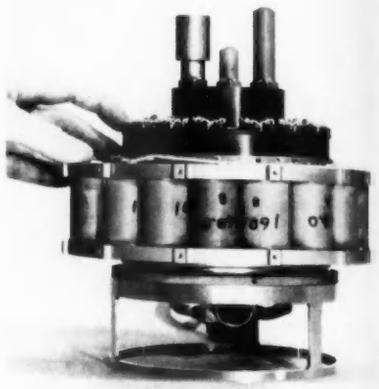
Special Article

PROBING

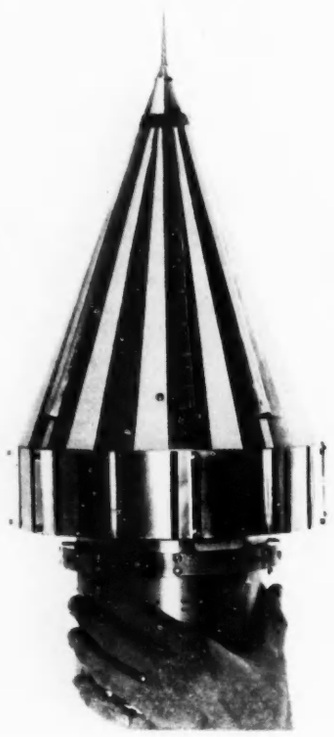
As recorded in Weekly Survey last week, the United States space probe Pioneer IV is now in orbit round the sun after passing within 37,000 miles of the moon. The 13·4 lb payload was launched by a four stage Juno II rocket. The space probe experiment was conducted by the National Aeronautics and Space Administration with the assistance of the United States Army.



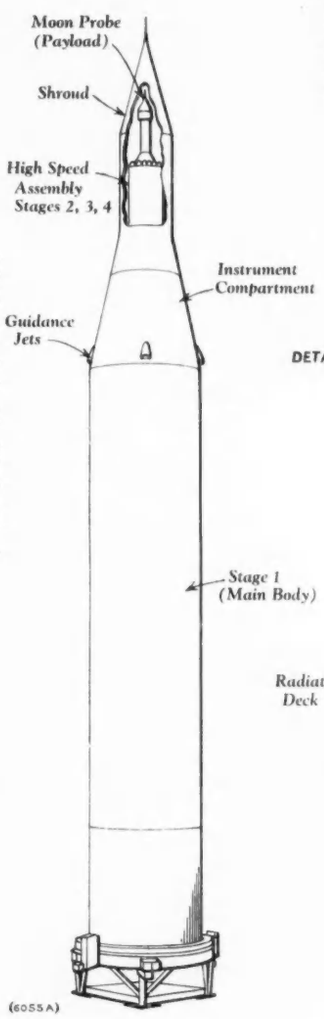
(Left) A Juno II vehicle, similar to the one which launched the US space probe, is shown on its pad at the Atlantic Missile Range, Cape Canaveral, Florida.



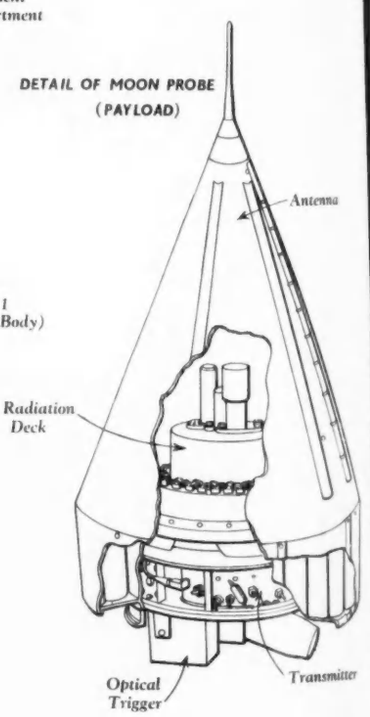
(Above) The instrumentation installed in the payload package: the two larger tubes at the top are for radiation measurement; the smaller is a voltage regulator. On the next deck is the radio transmitter surrounded by a ring of batteries. The lens of the photoelectric sensor is visible at bottom.



The Pioneer IV payload package: the Fiberglas outer cone is gold-washed to provide conductivity. The striped pattern is painted on to regulate temperature by controlling reflection and absorption of solar heat on the cone.



The Juno II launching vehicle and payload package in cutaway view: the Jupiter booster stage was provided by the Army Ballistic Missile Agency, Huntsville, Alabama, and the upper stages and payload by NASA's Jet Propulsion Laboratory at California Institute of Technology, Pasadena, California.



SPACE

ALMOST OUT OF THIS WORLD

X-15 Aeroplane soon to fly

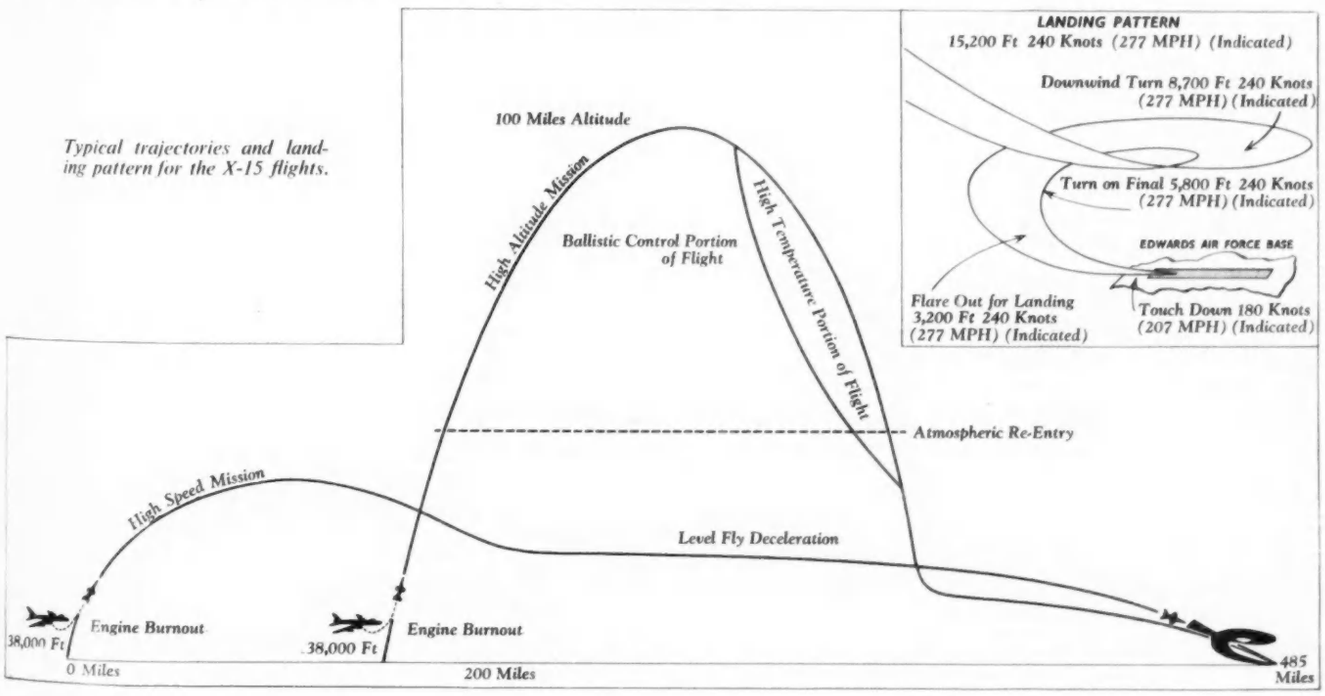
WITHIN a matter of months now, man may have penetrated beyond the earth's atmosphere for a brief excursion. The American X-15 upper atmosphere research aeroplane, designed and constructed by North American Aviation Incorporated, Los Angeles, has now completed its preliminary venture into the air, held securely under the wing of its mother aircraft, a modified B52 bomber. On its next flight, the X-15 will be launched from the air at some 38,000 ft—Mother B52 keeping a watchful television eye on the process—to make a power-off descent to Edwards Air Force Base. During the descent, North American's test pilot, Mr. Scott Crosfield, will have about two minutes in which to try out the handling of the aircraft before he brings it into the landing circuit. It is not until the fourth sortie that powered flight will be attempted, still within the lower layers of the atmosphere. On succeeding flights, gradually the flight plans will be increased in severity, building up to the design conditions of speeds up to 3,600 m.p.h. and altitudes up to 100 miles. Each test flight will last only about 20 minutes, of which only the first 5 to 6 minutes will actually be under power. After burn-out of the rocket fuel, the aircraft will continue to climb on a ballistic trajectory, as indicated in the accompanying illustration.

The main objective of the X-15 research programme, which is sponsored by the National Aeronautics and Space Administration, in collaboration with the US Air Force and US Navy, is to obtain knowledge of flight conditions at extreme altitudes, including exit from and re-entry into the earth's atmosphere. It will also provide some of the answers as to how man will react to several minutes of weightlessness and to the forces of acceleration and deceleration. To do this the aircraft has been built to carry man twice as fast and four times as high as he has flown so far.

The X-15, shown alongside, is 50 ft long, with lines that show little of its capabilities. Its stubby wings, set just forward of the tail, have a span of only 22 ft. Its take-off weight of about 15 tons will rapidly diminish as the fuel is burnt up. The wedge-shape fin, specially designed to give better directional stability at very high altitudes and speeds (although at some cost in drag) extends below the fuselage, the lower portion being jettisoned for landing. This lower portion is needed at high speeds during " pull-up" manoeuvres when the upper fin surface is partially shielded and ineffective.

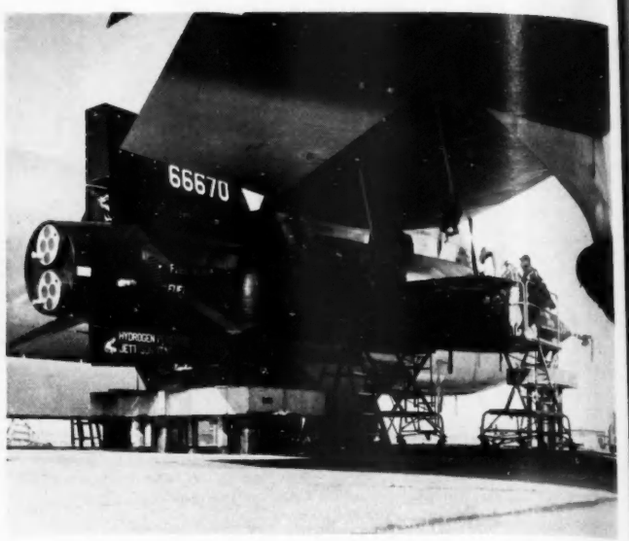
Separate control systems are provided for the aerodynamic and ballistic phases of the flight. The aerodynamic control surfaces on the tailplane act as both elevators and ailerons; the upper fin is pivoted for directional control, and both upper and lower fins house airbrakes. Power for operating the aerodynamic controls is supplied by an auxiliary power unit—a hydrogen peroxide turbo-generator set supplied by the General Electric Company. In the upper part of the trajectory, aerodynamic controls will of course be useless, and small control rocket engines, developed by the Bell Aircraft Company, are installed in the nose (100 lb thrust) and wing tips (40 lb thrust). These engines also operate on hydrogen peroxide fuel. An autostabilising

The North American X-15 upper atmosphere research aircraft.


LANDING PATTERN
15,200 Ft 240 Knots (277 MPH) (Indicated)
Downwind Turn 8,700 Ft 240 Knots (277 MPH) (Indicated)
Turn on Final 5,800 Ft 240 Knots (277 MPH) (Indicated)
EDWARDS AIR FORCE BASE
Flare Out for Landing 3,200 Ft 240 Knots (277 MPH) (Indicated)
Touch Down 180 Knots (207 MPH) (Indicated)
100 Miles Altitude
High Altitude Mission
Ballistic Control Portion of Flight
High Temperature Portion of Flight
Atmospheric Re-Entry
High Speed Mission
Level Fly Deceleration
Engine Burnout
38,000 Ft
0 Miles
Engine Burnout
38,000 Ft
200 Miles
485 Miles

Typical trajectories and landing pattern for the X-15 flights.

Continuing **Probing Space**



The X-15 secured under the wing of its mother B 52 aircraft before its first captive flight.

system designed to correct any oscillatory tendencies in yaw, pitch, roll, or combined roll and yaw, has been developed by Westinghouse. The entire control and stabilising system, including that essential component, the pilot, have been tested under violent acceleration in a flight simulator built into the US Navy's centrifuge.

To provide extremely accurate sensing of velocity, distance, altitude and aircraft attitude, an inertial guidance system, capable of withstanding accelerations of 10*g*, has been developed specially for the X-15 by the Sperry Gyroscope Company. The attitude determination is particularly important, since an error of 2° to 3° nose-up could send the aircraft several miles higher than intended; and, similarly, " a too-steep nose-down attitude on re-entry would cause the X-15 to burn up like a meteor " (A. R. Sorrells, *High Range*, pp. 4-23, North American Aviation Inc., *Skyline*, vol. 17, No. 1, winter, 1958).

Initially the X-15 aircraft will be powered by two 12,000 lb thrust reaction motors XLR 11 rocket engines, operating on water alcohol and liquid oxygen propellents. Later they will be replaced by a single larger engine, also by reaction motors—the 50,000 lb thrust XLR 99, which will operate on liquid oxygen and anhydrous ammonia fuel. Both engines provide variable thrust. Because of evaporation, the aircraft oxygen tanks are not charged before take-off, as are the fuel tanks; quick-disconnect lines between the X-15 and the B52 allow nitrogen and liquid oxygen to be fed to the research craft immediately before separation.

Test instrumentation comprises some 656 temperature sensing elements, 104 strain gauges, and 140 pressure tappings, as well as control position measurements. The pilot, too, will be " instrumented "—a radiocardograph of his heart action and plottings of his body temperatures will be transmitted to the ground. Some of the test data will be recorded in the aircraft, but critical data will be telemetered and tape-recorded; certain temperatures and pressures vital to the operation of the aircraft will be monitored from the ground, and the pilot will be advised by radio telephone of any necessary action. An AiResearch cooling system is provided for the instrumentation, much of which is supplied by Lear Incorporated. The pilot will be in a pressurised nitrogen-cooled suit.

For collecting the information and for keeping track of the X-15, a radar and telemetry range 485 miles long and 50 miles wide, known as High Range, has been specially set up in the Nevada mountains, with stations at Wendover, Ely, Beatty and Edwards Air Force Base. The complete installation of radar tracking, data recording, radio and telephone communication systems, as well as road and building construction, was carried out by the Electronics Engineering Company, Santa Ana, California.

SPACE FOR THE COMMONWEALTH

The step forward from artificial earth satellites to lunar probes, taken by both the United States and USSR, leaves little doubt as to the scale of effort in space research in those countries. More doubtful is the role of the United Kingdom in this field of investigation. Much valuable observational work has been carried out at stations such as Jodrell Bank and RAE Farnborough, while the Skylark rocket upper-atmosphere research programme has been successfully undertaken. But as yet Britain has not entered the space race and economic considerations rule out the possibility of her doing so.

The British Interplanetary Society, 12 Bessborough Gardens, London, SW1, however, declare that Britain cannot afford to ignore space research. They suggest that " very quickly, we could find ourselves devoid of important new industries born of the space age—perhaps on a par with those European nations which, in the first quarter of this century, failed to keep abreast of developments in aviation, and today have to import aircraft." And they conclude that a space research programme should be undertaken in collaboration with the Commonwealth. Suggestions for such a programme were made last year. They envisaged an extension of the Skylark programme, the development of clustered and staged rockets, adaptation of the Black Knight and Blue Streak missiles for launching satellites, and the investigation of manned flight on the fringe of space. It is now announced that to enable a wider discussion of these and similar topics a Commonwealth Spaceflight Symposium is being organised by the society. It will take place on 27 and 28 August in London, immediately prior to the 10th Congress of the International Astronautical Federation.

The symposium is timely. Already aircraft developments have tightened the links of the Commonwealth; the process could be furthered by communications satellites, perhaps with the introduction of a Commonwealth television programme relayed by them. In addition, weather satellites could make an important contribution to Commonwealth economy.

BLACK KNIGHT ROCKET FIRED

The second Black Knight ballistic rocket test vehicle was successfully fired at the Australian rocket range at Woomera on 12 March. At the peak of its trajectory Black Knight reached an altitude of approximately 350 miles. The firing is one of a number planned to obtain further scientific information.

Black Knight was designed by a team headed by the Royal Aircraft Establishment of the Ministry of Supply, and firing tests are taking place in collaboration with the Weapons Research Establishment, Australia. Working in close association on this project with RAE are the principal contractors, Saunders-Roe Limited, Cowes, Isle of Wight. Armstrong Siddeley Motors Limited, Coventry, have developed the rocket engine from a design produced by the Rocket Propulsion Establishment, Westcott. After rising vertically under its own power from the launcher the vehicle is controlled to climb, still vertically, for several thousand feet, after which it is directed, while still under power, into a climb path towards the target area. From the point of engine cut-off the missile coasts upwards in free fall to an apogee of several hundred miles and then descends.

Measurements of the behaviour of the rocket engine, the control and guidance and the conditions when the motor is accelerating the rocket, together with its environment and other phenomena under investigation, are continuously made throughout flight and relayed to a number of ground receivers along the range by several telemetry transmitters installed inside the missile. Its behaviour during its re-entry into the earth's atmosphere is also recorded. Additional information is obtained by tape recorders and by recovery of the vehicle after impact.

In Parliament

STUDYING USSR PROGRESS

Members of the House of Commons put forward pleas last week for expanding the cultural co-operation between Britain and Russia. Mr. Julius Silverman (Labour) wanted favourable consideration to be given to the proposals of the Soviet Government for a "cultural co-operation treaty," on the lines of those already concluded with the United States and France.

Mr. John Rankin (Labour/Co-operative) asked for favourable consideration to be given to the proposals for expanding trade and cultural relations between the two countries, first made by the Soviet Government to the United Nations' Economic Commission for Europe in April, 1956.

In respect to these matters, Mr. Robert Allan, Joint Under-Secretary of State for Foreign Affairs, said that the British Council's Soviet Relations Committee would shortly be visiting Moscow to arrange a programme of technical, scientific, cultural and educational exchanges between this country and the Soviet Union. The delegates would be led by the chairman of the committee, Mr. C. P. Mayhew, Labour member for East Woolwich. Such an arrangement, together with those exchanges which it was hoped would be made privately and commercially, were more likely, in the Government's opinion, to give results than formal treaties. Britain had her Soviet Relations Committee, but neither the United States nor France had any kind of counterpart to that committee.

The proposals referred to by Mr. Rankin were made in the form of a draft treaty covering a large number of subjects and, in the main, expressed only in general terms. They had been thoroughly discussed by the Commission in the spring of 1957 and a number of the proposals had already been the basis of useful work.

COMMONWEALTH FINANCE

Details of the resources available to the Commonwealth Development Finance Company since the Montreal Economic Conference were asked for by Mr. P. Maitland (Conservative). He was told by Mr. F. J. Erroll, the Economic Secretary to the Treasury, that the Organisation referred to was a private company and that any arrangements for increasing its resources were matters for the company's board of directors.

According to a recent announcement in the press, however, the company, foreseeing increased demands for development capital by Commonwealth countries, had invited a number of large British industrial and commercial companies to become shareholders. Such companies would be in addition to the 91 concerns in private industry, commerce and finance who were already shareholders.

The Bank of England, while remaining a minority shareholder, was ready to take up further shares. It would be recollected that the report of the Montreal Conference had stated that the Bank of England was ready to consider the provision of further resources to the company.

GOING OUT OF LONDON

The House was informed by Mr. J. E. S. Simon, the Financial Secretary to the Treasury, that an agreement had been reached in 1948 with the staff side of the Civil Service National Whitley Council for the dispersal out of London of about 45,000 civil servants. The agreement, he said, contained certain undertakings to the staffs, of which the most important was that moves would be made only to places where certain standards of housing and other social amenities, such as schools or transport facilities, would or could be made available.

A great deal had been done. About 27,000 civil servants had already been dispersed. For example, the Admiralty had over 4,000 of its staff at Bath; the General Post Office had 1,200 staff at Enfield; and there were over 1,000 from the Premium Bond Division at Lytham St. Annes. The Ministry of Pensions and National Insurance had placed 3,700 of its employees at Blackpool, having, in effect, dispersed all its staff except a small London nucleus.

Also, there were some 6,800 civil servants engaged on national insurance work at Newcastle upon Tyne. Other examples could be quoted. The Air Ministry, for instance, had placed 3,000 employees at Worcester. The dispersal of Government staffs was subject to two over-riding considerations. A dispersal must not cause serious loss of efficiency in the public service and it was necessary to secure the support of the staff concerned.

A DEPARTMENT FOR DURHAM

This information was given during the course of a debate, originated by Mr. Charles Grey (Labour), regarding the possible transfer of a Government department to Durham. He referred to his many previous efforts to get satisfaction and said that the problem had existed for at least eleven years, because it was in 1948 that, under the Government's dispersal policy, it had been decided that the Land Registry should be sited in Durham. The Registry's establishment there was to have been completed by 1960.

The future plans of both the Durham County Council and of the City Council had been coloured by the knowledge that a Crown department was to be located in Durham. The City Council, for example, had bought land over and above its normal requirements, because, if a Crown department were sent to Durham, housing accommodation would be required for 800 to 1,000 employees and their families. It was true that an offer had been made to send a section of the Ministry of Education to Durham, employing a little over 350 persons, but that was not good enough. A Crown department would be a terrific asset. There was no finer place than Durham and no finer human material to fill the jobs that would become available.

Mr. J. E. S. Simon, after relating, as stated above, the achievements of the Government in connection with the dispersal of Ministries into the country, said it was necessary to see whether there was some department which could conveniently be sent to Durham. The Government must carry the staff with them in any such decision and, obviously, it would be wrong to select a department which had been earmarked already for some other authority. Subject to these provisos, he was most anxious to find a department to go to Durham.

MALTA DEEP WATER HARBOUR

Air-Commodore Sir Arthur Harvey (Conservative) inquired about tenders for a new deep-water harbour at Malta and asked the Secretary of State for the Colonies to bear in mind that it was unfortunate, with all the millions of British taxpayers' money going into Malta, that this business had been given by contract to a continental firm at a time when British firms badly needed work.

Mr. Julian Amery, the Under-Secretary of State, replied that tenders for the harbour had been invited on the basis of open competitive bidding. The tender of the Royal Netherlands Harbour Works Limited was accepted on the recommendation of a United Kingdom firm of consulting engineers. The lowest British tender was about £89,000 more. The award of the contract had been made by the Malta Government and it had not been the policy of the British Government to make financial aid to a territory dependent on the award of contracts to British firms.

RAILWAY WAGON BUILDING

Attention was drawn by Mr. G. M. Lawson (Labour) to the threatened closure of the railway wagon-building firm of Hurst Nelson and Company Limited, Motherwell. He referred to the Government's policy of seeking to encourage employment, especially in areas where more than 8 per cent of the workpeople were out of jobs, and asked the President of the Board of Trade to take immediate steps to see that this old-established firm, which at one time had employed 600 workers, was not closed. Mr. John Rodgers, the Parliamentary Secretary to the Board, replied that the position was much regretted. Closure, however, must depend upon the commercial judgment of a firm's management. In this case, the Controller of the Board of Trade had done all he could to assist by advising the firm of all the sources known to him from which work might be available, but the Board had no powers to direct work to a particular firm.

INVESTIGATING THE AURORA

A new radar station being built near Aberdeen was the subject of a question by Mr. Hector Hughes (Labour) to the Minister of Supply. Mr. Hughes said that the foundations of the station had recently been laid by agreement between the British and United States Governments and he asked for an explanation of the station's purpose. He was informed by Mr. W. J. Taylor, the Parliamentary Secretary to the Ministry, that, as previously stated, the station was being erected on high ground in an isolated position at Hillhead, near Fraserburgh. Its purpose was to obtain more knowledge of the properties of the aurora and its effects on the propagation of radio waves, as part of a programme of ionospheric studies.

The site should be prepared and the equipment assembled by June. Observations would then begin and were expected to last for one or two years. Precautions were naturally being taken to avoid interference with the local reception of radio and television. There would be no danger to people or to livestock through radiation from the station.

Distribution of Industry

Some 50,000 letters were sent out by the Board of Trade in February last to managing directors throughout the country, drawing their attention to the assistance which the Government were prepared to give to firms setting up factories in Aberdeen and the Highlands. Mr. Cledwyn Hughes (Labour) and Mr. Hector Hughes (Labour) asked the President of the Board about the progress which had been made. Mr. John Rodgers said that the letters did not seek replies, but, so far, approximately 820 firms had written either to the Board or to the Development Areas Treasury Advisory Committee. Of that number, 288 had been identified as being potential applicants for loans or grants.

Wood Production

Sir Alfred Bossom, Bt. (Conservative) asked the President of the Board of Trade how much hard and soft wood was imported into Britain during the period between the First and Second World Wars, and since the Second World War. Sir David Eccles said that, between 1919 and 1939, some 664 million cub. ft of hardwood and roughly 40 million standards of soft wood, including sleepers, were imported into the United Kingdom. Comparable figures for the years 1946 to 1958 were approximately 513 million cub. ft and 19 million standards, respectively. Total exports of wood from the United Kingdom were published in the Trade and Navigation Accounts. It should be noted, however, that exports of hard and soft woods were not separately distinguished in these returns.

Progress on North Eastern Trading Estates

Mr. Paul Williams (Independent Conservative) asked the President of the Board of Trade for details of employment on trading estates in the north-east. He was informed by Sir David Eccles that, in the factories administered by North Eastern Trading Estates Limited, there were 7,175 males and 11,918 females in employment in December, 1946. This total of 19,093 had risen steadily year by year until November, 1957, when the total number of persons at work was 53,140, comprising 22,906 males and 30,234 females. In November, 1958, however, the total had declined to 50,453, made up of 21,728 men and boys and 28,725 women and girls.

The Human Element

The Rate for Higher Service

Comments on the recommendations of the Coleraine Committee in respect of higher civil service salaries have been made by Mr. Stanley Mayne, general secretary of the Institution of Professional Civil Servants, in the March issue of *State Service*. Expressing his satisfaction that the committee should have undertaken the review and recommended the increases, Mr. Mayne goes on, by implication, to criticise the committee for not making a more thoughtful review of senior salaries. "It is reasonably clear," he writes, "that what they have done is to take the increases given in the Civil Service since the publication of the Priestley Report and applied these increases to the higher grades, merely making appropriate roundings."

The application of a straightforward tariff to all senior grades has done nothing to maintain the differentials between grades which made a successful Civil Service career so attractive before the war. The managing director of a medium-sized engineering firm now earns as much as (in some cases substantially more than) the Permanent Secretary to the Treasury who, besides being the head of an organisation far larger than most firms, is also the head of the Civil Service. His salary has been increased by £1,000 a year to £8,000 and the salary of his colleagues in other departments by the same margin to £7,000 a year. Granted that the status, in social terms, of a Permanent Secretary is above that of the managing director of a firm employing 1,000 people, it is comparable with that of the chairman of a major company—whose salary will rarely be less than £15,000 and in some cases over twice that figure.

After School What?

The National Union of Teachers are making great efforts to help youngsters to find worthwhile jobs. In less than three months time they will be holding the first National Education and Careers Exhibition (Olympia, London, 26 May to 5 June). Last week they published a much improved and expanded edition of their *Annual Guide to Careers for Young People*.

The NUT's general secretary, Sir Ronald Gould, points out in his introduction that in a large number of areas the days of jobs in plenty are gone. "Worse still," he says, "in parts of England and Wales today school-leavers are experiencing at least temporary unemployment. All of us must hope that this state of affairs will not last. As a nation, we cannot afford to waste the potential skill, the energy and the enthusiasm which the present generation of school leavers offers. Here is a real challenge to stock up with youngsters who are as good, if not better than any that have emerged from our schools for many a year." In spite of the employment difficulties and the emergence of the "bulge," the number of firms supporting the NUT'S careers guide has increased and there are signs that many fully share Sir Ronald's concern with the present situation. In the foreword, Sir Hugh Beaver, President of the Federation of British Industries, emphasises that the guide provides practical information and advice for those charged with the task of giving careers guidance in schools.

The National Education and Careers Exhibition is being held under the patronage of the Queen, who will herself pay it an informal visit. It has the full support of the Ministries of Education and Labour as well as of the Federation of British Industries, the British Employers' Confederation and the Trade Union Congress, and nearly fifty major industries and undertakings. The careers section will show the opportunities which exist in industry. The education section will provide live and static displays giving a complete picture of the educational system operating in Britain. More than 4,000 pupils, students and teachers will be taking part in demonstrations of various kinds and in a programme of events in the exhibition theatre.

Dartmouth Up to Date

Changes have been made in the entry regulations to the Britannia Royal Naval College, Dartmouth, with the following objects in mind: "to ensure that young officers receive training which will develop their personal qualities and powers of leadership," and that they should "receive academic and professional technical training appropriate to this nuclear and electronic age."

The educational standards for cadetships will be raised to two A-level passes and also passes at O-level in the General Certificate of Education. The first two years will be spent on naval training, one at sea in the fleet as midshipman. Engineering and electrical specialists will do a degree course in mechanical engineering.

Spring Manoeuvres

In the last week there has been a good deal of manoeuvring on the trade union front for the wage struggle of 1959. The election of Mr. W. Paynter to succeed Mr. Arthur Horner offers a promise of storms in the coal fields. One Communist has succeeded another as general secretary and a struggle may lie ahead both with the National Coal Board and within the NUM, for Mr. Ernest Jones the president is an anti-Communist and perhaps less disposed to let a new general secretary stray from his desk into the negotiating and political field than the old one.

The National Union of Railwaymen has given notice of a new and large pay claim to come irrespective of the inquiry on wages which came out of last year's negotiations. The AEU is having a pre-Easter meeting on how to go ahead with the demand for the 40-hour week without getting entangled with the rest of the trade union movement.

By a stroke of irony the TUC has recently announced that it is to try to make progress with a mild form of rationalisation of the trade union movement. If this means a touch of spring cleaning, spring looks like being a little late this year.

House Magazines Reflect

The role of the house magazine in business was discussed at a conference of house magazine editors organised by the Industrial Welfare Society and held at Brighton last week. It was attended by more than 80 industrial editors from all over the United Kingdom.

The similarity of appearance of most house magazines was criticised by Mr. Richard Wilson, of Unilever. "If you took at random 100 magazines from a bookstall," he said, "and got hold of a similar number of house journals, you would find a much higher proportion of house journals tended to look alike and lack individuality." Too many failed to reflect the personality of the firms and the very different backgrounds of industry in which the firms operate.

Mr. Dennis Robinson, a director of George Berridge and Company, printers, told the conference that editors should seek the printer's help and advice, and give up the demy octavo size which allowed very little scope for imaginative lay-out. He recommended royal octavo, crown quarto or demy quarto as sizes allowing more opportunity and also cutting more economically from standard paper sheets. A film on the production of *Nuts*, the monthly staff magazine of J. Bibby and Sons, was presented by Mr. Trevor Owen, a Monotype operator, on the staff of Regent Press (Bootle) Limited, who print it.

The purpose and objects of house magazines were discussed by Mr. J. S. Skinner, chairman and managing director of Remington Rand Limited. To him, the house journal is an important means of communication for, he said, "the problem of keeping in touch with one's employees is always with us, and is very real when a company reaches a size where it is not possible to maintain personal contact with the majority of its personnel." Mr. Skinner's discursive review of the contents of an actual issue of *Remington Rand News* was a most interesting exposé of what thinking should lie behind the production of a house magazine, how it can have a personality of its own and be eagerly awaited by its readers.

Old Mortality

Wherever one looks there are signs of the remarkable and at times rather disturbing effects which improved mortality rates are having on population. Some alarming figures have recently been produced about the level of world population by the end of this century if current mortality rates are maintained along with current birth rates. The more reassuring side of such statistics comes out in examining the effect of better mortality rates on the age of the working population in this country.

A booklet has been issued by the Ministry of Labour called *The Length of Working Life of Males in Great Britain* (HMSO, price 3*s* 6*d*). It shows that the average expectation of working life in this country has increased for males by 12½ per cent between 1931 and 1955. On the average, boys of 15 can now expect to have 48·4 years in the working age groups—that is until they are on the average 63 years of age. At the other end of the scale, 75 per cent of the men aged 65 can expect to stay in work to a later age, but 31 per cent should anticipate retirement before their 66th birthday.

These facts are important in an age of higher insurance benefits and a higher average age of the population. They suggest that the burden on the younger age groups of keeping the older ones pensioned off may be more evenly spread than was at one time expected.

East-West Reversed Charges

Mr. Macmillan's insistence that we should solve the problems between East and West by talk rather than by war has had one very apposite and practical result. Transferred charge calls between here and Russia which were instituted for the Prime Minister's visit are to remain. If you want to discuss something with a Russian over the telephone, and you think that he will accept the charge for listening to you, you can now try it on. Equally the system will work the other way. Since the use of switchboards is at a minimum in Russia and many telephones are connected directly to exchange like private subscribers in this country, the main problem may still be to get through at all no matter who is to pay for the call.

The reversed charges to zone one in Russia, which includes Moscow, Kiev and Leningrad, will be 34*s* 6*d* for three minutes. To other zones the charge will be higher. The higher charges to these zones is due to the cost of land cables over large areas which have to be paid for by a comparatively light traffic in many parts of Russia. The ordinary charge for a call from this country to zone one is 21*s* for three minutes. The cost of a transferred charge call is therefore comparatively much higher. Even low-level discussions with the Russians are clearly quite an expensive business if there is to be bargaining about who pays for the call.

Continuing **The Human Element**

AN OVERLOAD RATING FOR HUMAN BEINGS?

Fitting the Job to the Worker

By K. F. H. MURRELL

In an opening address to the first conference organised in 1951 by the newly-formed Ergonomics Research Society, Sir Ben Lockspeiser, then secretary of the Department of Scientific and Industrial Research, said[1]: "Machines . . . are becoming more and more complicated, with a corresponding tendency to become more difficult to control. We can no longer afford to leave the human operator to get along as best he can . . . Relatively speaking we know much about how machines work and so little about how the mind and body work . . . Yet there is an intimate connection between the machine and the person who uses it."

In the eight years which have elapsed since these words were spoken scientists from the relevant disciplines of anatomy, physiology, psychology, engineering and industrial medicine have got together both nationally and internationally to attempt to increase our knowledge of how the mind and body work. At the same time some engineers in a few forward-looking firms have realised that it is important to know as much about the stresses on and limitations of the human being as it is of the stresses and limitations of materials, if successful man-machine units are to be designed which will realise the fullest potentialities of both the machine and the man.

It was with the object of bringing industry (both employers and trade unions) and scientists together to discuss the contribution which ergonomics (the scientific study of human work) could make to solving industry's problems that the European Productivity Agency launched its Project 335 which has just been completed. This took place in three phases. In the first a team of seven scientists from different European countries were sent to the United States in the autumn of 1956 to find out what was being done there. This team was carefully chosen so that physiological, psychological and engineering interests were represented and was accompanied by a representative of the European Free Trade Unions and a British secretary.

The report of this mission was placed before a gathering of some 70 scientists drawn from 12 countries in a technical seminar at Leyden[2] in the spring of 1957. The object of this meeting was to enable scientists from different countries to exchange information on a series of specific research questions which would form the basis of material to be used in the third and final phase of the project. An important side product of this seminar was the setting up of an international committee on ergonomic sciences to organise future international conferences, the first to take place in Stockholm in 1961.

The third phase of the project was a tripartite conference which has just taken place in Zurich from 2 to 6 March. It was attended by about 190 persons representing employers' organisations, trade unions, together with a group of scientists whose task it was to present the research findings to the industrial representatives. The general feeling at this conference was that more could be done to give guidance to industry along the lines of the information which has already appeared in ENGINEERING.[3]

There was a need, too, for facilities to train engineers in ergonomics, since it is they, finally, who will have the responsibility for the use of the available data. Some countries, notably Switzerland and Germany, are introducing some biological material at the undergraduate level. In this country lectures are given to post-graduate students in production engineering at Birmingham University, while the work study department of the Engineering and Allied Employers' West of England Association are now running full-time courses in Bristol. The feeling of the conference was that this was quite inadequate, and that the technical colleges in particular should develop courses in ergonomics.

It seemed that a major difficulty experienced by those from industry in seeing the need for or the usefulness of ergonomics arises from the great adaptability and variability of human beings. Thus a man may continue to work on a highly unsatisfactory machine or in an unsatisfactory posture for years without, apparently, suffering any great ill-effects or loss of efficiency, and as a result there is no pressing need to make changes in equipment or working methods. The operative word here is "apparently," since we do not yet know what is the cost to the man of this forced adaptation. Evidence is accumulating which suggests that it may be far greater than is usually suspected and that ultimate losses in production may be quite substantial. The effect of these accumulated stresses may show up only when an individual is called upon to meet an unusual situation and then, because he is unable to meet it, disaster may result which may have dramatic and far reaching consequences—as in recent transport accidents.

To see how this can occur, think of an individual as having a certain amount of available capacity for work; if the demands of the job are high it may still be within his capacity but there is less reserve to meet further demands which may come upon him. Moreover, this available capacity will decrease with age and it seems likely that this decrease will be greater when the demands of the job are high, leading to separation from the job at an unnecessarily early age.

This conception can be used for both the physical and mental components of work. Several speakers pointed out that over long periods individuals should be called upon to do physical work of not more than one quarter of the maximum of which they were capable, other wise breakdown would occur. Where the job demands that physical work in excess of this be done, there is a definite and measurable limit to the time which should be spent before a rest period is taken; if this is exceeded the recovery period increases very rapidly. For instance, 30 minutes work at a high level may require 5 minutes recovery, but 60 minutes work will require 20 minutes recovery. In fact, individuals will attempt to prevent overstrain by taking what the Germans have described as "hidden rest." Examples were given of instances where the arrangement of short and frequent rest pauses to suit physical demands increased production and eliminated hidden rest.

The biological basis of shift work was treated at some length. It was evident that the normal week-on/week-off nights was the worst system physically, since there is evidence that it takes nearly a week for many men to adapt their physical rhythm to the change in activity. However, it was admitted that here again the extreme adaptability of men may play a part, and that men may become acclimatised to these frequent changes; it was emphasised that more research was needed before the effect of shift work would be clearly understood. Evidence from Scandinavia showed that there was greater ill-health in shift workers who changed weekly than those who changed monthly or at longer intervals.

It was pointed out by several speakers from industry that heavy physical work was rapidly disappearing and that in fact many processes would operate in future without any human intervention at all. This is true only in part. Machinists may be replaced by large automatic assemblies but this in turn raises new problems of fault finding and maintenance in which the economic cost of human efficiency may be enormous. In addition, since no plant however automated can be completely free of human control, the operator may become increasingly a receiver and processor of information. The limitations of man in this role were discussed. It was pointed out that the brain is a single-channel mechanism, that information can pass along this channel at a limited rate, and the information conveyed by an event will depend upon the probability associated with its occurrence. Moreover, while one piece of information is being dealt with, the receipt of further information is inhibited. Even after information has been received it takes an appreciable time for action to be taken.

While automation may be on the way in large-scale manufacturing, the major part of industry is still likely for a long time to come to depend on the efficiency of individual operators, and speakers at the conference touched upon a number of factors which should be taken into consideration by designers, such as design and placement of controls, methods of presentation of information, design of dials, lighting, noise, and control of radiant heat. Proper consideration of these at the design stage should go a long way towards reducing the load on the operator and so leave more of his available capacity to cope with overloads.

During the discussions, examples were given of actual applications. Among these were studies of spinning and the layout of bulldozer controls by the Centre d'Etudes et de Recherches Psychotechniques in Paris, the design of crane controls and cabs by BISRA. New sewing machine controls which substitute variable speed for slipping clutch were described by the British Boot, Shoe and Allied Trades Research Association, which result in reduced training time and improved speed of work of between 15 and 20 per cent. An indicator of machine-tool travel has been designed by C. B. Gibbs at the Applied Psychology Research unit at Cambridge which presents information in counter form instead of on a graduated scale and can result in production increases of up to 75 per cent. Regie Renault had on view some equipment used in research on the optimum position for seat and controls in motor vehicles, while many delegates bounced up and down on a platform to demonstrate the design of seating to absorb vibration. Research on railway signalling was demonstrated by the French National Railways.

At the conclusion of the meeting, representatives of both the employers and the trade unions summed up. It was clear that, even if they were not entirely convinced, the conference had raised their interest sufficiently for them to wish to pursue the matter further, probably on the national level.

REFERENCES

[1] W. F. Floyd and A. T. Welford (Editors), *Human Factors in Equipment Design*. London, H. K. Lewis, 1953.

[2] K. F. H. Murrell (Rapporteur General), *Fitting the Job to the Worker*, A Survey of American and European Research into Working Conditions in Industry. Paris, European Productivity Agency, 1958.

[3] K. F. H. Murrell, "Data on Human Performance for Engineering Designers," pp. 194, 247, 308, 344, 438, ENGINEERING, vol. 184, 1957.

Atomic Review

Supercritical

Excess activity, that has accumulated geometrically in recent weeks, is reported in the following notes.

Transient Reactor Test Facility Critical

The Transient Reactor Test Facility (TREAT) operated by the Argonne National Laboratory of the USAEC achieved criticality at the National Reactor Testing Station near Idaho Falls, Idaho, on 23 February, with 146 fuel elements containing a total of 5·38 kilograms of uranium235. (See Atomic Review last week.) TREAT is a nuclear reactor designed to produce short, extreme pulses of nuclear energy resulting in high temperatures. The derived heat will be sufficient to permit melt-down studies of samples of fuel elements and components intended for use in fast reactors. The TREAT facility will also provide a versatile irradiation tool for studying a number of other problems in the USAEC's fast reactor safety programme. The sub-pile room of the reactor facility is shown in Fig. 1 below. Early studies with the reactor will be aimed at determining the effect of extreme pulses of nuclear energy on prototype fuel pins for the Experimental Breeder Reactor No. 2 (EBR-2), now being built at the National Reactor Testing Station. A programme of metal-water reaction experiments is also anticipated.

The reactor is fuelled by uranium-oxide uniformly dispersed in graphite. For experimental flexibility space is provided for loading of a maximum of 361 fuel elements. The reactor cavity, 7 by 7 by 14 ft high, can accommodate a 6 by 6 by 4 ft high fuel core. Fuel assemblies are almost 9 ft in length and consist of an upper and lower graphite section and a 4 ft central section of uranium oxide-bearing graphite which is the active (fuelled) section. This central fuel section contains six 8 in long fuel blocks canned as a unit in zirconium alloy. The end sections, which do not contain uranium are canned in aluminium. Inside the reactor cavity, surrounding the TREAT fuel core, is a lining of graphite blocks which serves as a reflector to reduce the escape of neutrons from the system. With the lowering of neutron economy the chain reaction diminishes and the reactor becomes self-limiting. In other words, as the graphite becomes overheated its moderating effect is diminished, so automatically governing the reaction. The transient pulses produced by momentary supercritical conditions, are believed to be of greater intensity than those which can be safely attained in any other nuclear reactor. The cost of the complete facility is said to be £1 million.

In the illustration a technician is shown checking the solenoid-operated latch of a control-rod drive during installation in the sub-pile room of the Transient Reactor Test Facility. The four control rod drives each drive two control rods up through the reactor under pneumatic pressure during reactor operation to speed their action in case of a scram (instantaneous shutdown). With a cylinder pressure of 350 lb per sq. in, the rods will drop through a 4 ft stroke in 90 milliseconds. The complete tubular control rod weighing 65 lb consists of three sections: a nickel-plated carbon-steel section which contains boron carbide powder as the neutron absorber; a graphite-filled Zircaloy section; and a graphite-filled, oxide-coated, carbon-steel section connected to the drive mechanism.

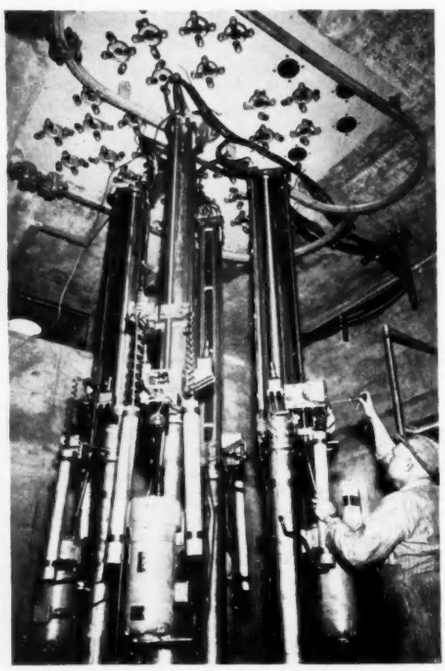


Fig. 1 Sub-pile room of the Transient Reactor Test Facility at the National Reactor Testing Station operated by the Argonne National Laboratory.

Construction of the Dounreay Fast Reactor

The construction of the Dounreay fast reactor was discussed at length in a series of articles which appeared in Engineering on 17 May, 24 May and 7 June, 1957. Particular reference was made to the reactor vessel. Recently the Fairey Aviation Company have published details of their work in fabricating the core skirt, and stages in manufacture are shown in Figs. 2-5.

Euratom

Euratom Constitution

The first general report on the activities of the European Atomic Energy Community, Euratom, has recently been published. Its contents are in two parts, the first concerned with the Community's institutions, the second with the application of the treaty—research and education, dissemination of information, nuclear industry, energy and economy, supply, control and safety, health protection, and the external relations of the Community. The organs of the Community are: the European Parliamentary Assembly, which is common to all three European communities (ECSC, ECM and Euratom); the Euratom Council, which is responsible for policy; the Euratom Commission, which under its President, M. Louis Armand, is the executive body of Euratom; the Court of Justice, which will arbitrate for the three communities; and the Economic and Social Committee, which is an advisory body to the Euratom and European Economic Community Councils.

Euratom Supply Agency

One of the main functions of Euratom is to control the supply of raw materials, metal ores, and special fissile materials for all the Six Community countries. This task is carried out by the Supply Agency which is under the control of the Euratom Commission. To help it in its duties the agency has a consultative committee which met for the first time on 24 February in the presence of M. Etienne Hirsch, the president of the Commission. The consultative committee has 24 members and will help and advise the agency and form a link between it and its customers. The agency has a right of option on the materials produced in the territories of the member states. In his speech at the first meeting M. Hirsch said the " principle of equal access to resources in the corner-stone of the provisions of the treaty with regard to supply." The maintenance of supplies provided for in the treaty involves commercial activities in which the Community itself cannot take part. This is where the agency will intervene and carry out the commercial side of the operation. M. Hirsch went on to say that the agency was starting work at a time when there was no reason to expect scarcity in the foreseeable future. The work of the agency will be largely confined to acting " as a good agent " bringing suppliers and buyers together. At the moment there is no question of the agency building up stocks either for commercial purposes or for security.

UK-Euratom Agreement

The provisions of the United Kingdom-Euratom agreement, announced in Atomic Review last 6 February, are three-fold; namely, the exchange of information, licences and training facilities; the suspension of tariffs on reactors, reactor components and heavy water; and arrangements for the supply of fuel and repurchase of surplus plutonium by the UKAEA at commercial prices. Under the agreement a permanent joint body will be set up between Euratom and the United Kingdom to hold periodic mutual consultations within the framework of the agreement; initially there will be a standing committee at technical level, but consideration is being given to the creation of a supervisory body at ministerial level. The agreement is to operate for 10 years.

United States Joint Programme with Euratom

The Commission of Euratom and the United States Atomic Energy Commission have announced that the Joint Research and Development Board will begin meeting early in April to consider proposals concerning the joint research and development programme. It is expected that the greater part of the programme will be concerned with research on reactors to be built under the US-Euratom Agreement which came into effect on 18 February. The overall industrial objective of this agreement is the installation within the next five to seven years in the Euratom Community of United States power reactors, either of the pressurised water or boiling water type, having a total electric generating capacity of one million kilowatts. No specific deadline has been set for the submission of proposals for items for the research and development programme. Any knowledge gained from this work will be available to the governments and industrial firms of the United States and the Euratom countries. The sort of work which the Joint Board has indicated might be usefully carried out now, falls into eight categories as follow: (1) the study of specialised reactors for testing fuel elements; (2) the chemistry, metallurgy and behaviour of fuel materials; (3) manufacture of fuel elements especially with a view to exploring new techniques, and the causes of corrosion of materials for containers; (4) research in moderators; (5) technology of reactor elements; (6) heat transfer; (7) treatment and manipulation of irradiated fuel; and (8) problems of wastes.

Notes and News

Alternative to Zeta

A departure from the single line of fusion research hitherto followed in Britain is to be made at AWRE Aldermaston. Whereas the major part of previous research has been concerned with toroidal containment and machines of the Zeta family, a new group is to investigate thermonuclear experiments utilising the injection of pre-accelerated particles into magnetic fields with mirror geometry. Initial lines of research will include the investigation of methods of producing highly-ionised low-density plasmas and the investigation of the adiabatic trapping of high-energy particles by mirror fields. A large machine using these techniques is contemplated and the group's work will ultimately be concerned with this.

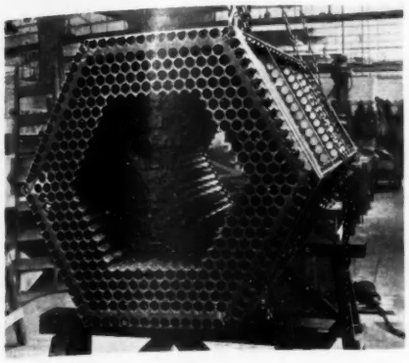


Fig. 2

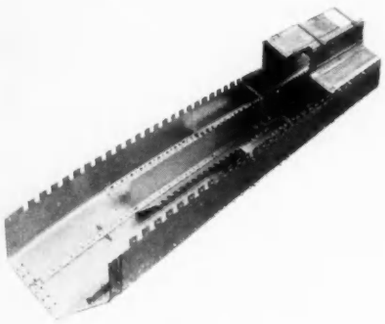


Fig. 3

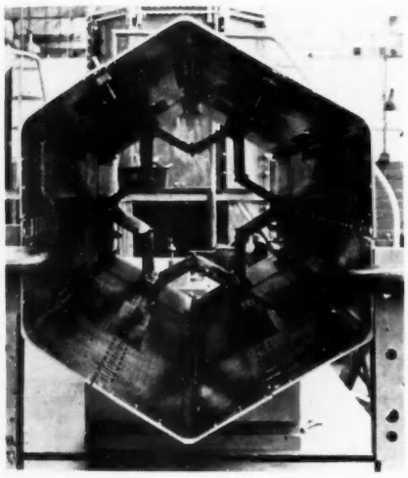


Fig. 4

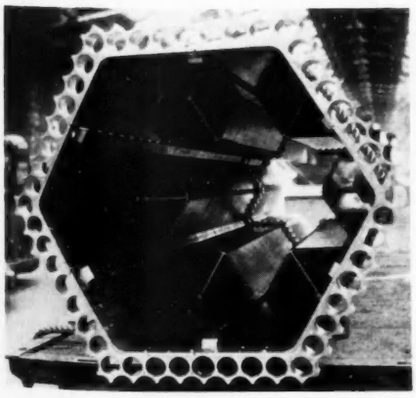


Fig. 5

Fig. 2 Gagging skirt for the Dounreay fast reactor made entirely in stainless steel (18-8-1) and weighing 30 cwt.

Fig. 3 Core skirt partly assembled and showing star-shaped fabrication at lower end of 18/8/1 casing and V-shaped members. Castellations assist assembly and dispense with overlap.

Fig. 4 Interior of core skirt less V-members but showing S.80 guide strips.

Fig. 5 Core skirt for Dounreay fast reactor after final assembly. It weighs 14 cwt and is 9 ft long.

CEGB Laboratories at Berkeley

At a cost of about £1,000,000 a new major research centre is to be established by the Central Electricity Generating Board adjacent to the Berkeley nuclear power station in Gloucestershire. It will consist of engineering, physics, metallurgy and chemistry laboratories. Some of the laboratories will enable studies to be made of intensely radioactive materials; in addition, laboratory accommodation has been incorporated for work with materials having no radioactivity but giving rise to a toxic hazard. The research centre will be self-contained and administratively divorced from the power station, although architecturally the buildings will be in keeping with others on the site.

Facilities will be available for general engineering development work connected with operating problems arising during the lifetime of the reactors. Among the sort of work envisaged could be included heat-transfer and fluid-flow problems, some unit processes in chemical engineering, the development of complicated structures and mechanisms for the study of engineering designs and materials and the study of stresses in massive structures.

One of the functions of the laboratory will be to give a constant appraisal of the state of materials used in the construction of the reactors by detailed examination of monitor samples removed on a programmed basis from the board's operating reactors, so that full knowledge exists of the condition of the reactors components.

Xi-Zero Particle Discovered

An atomic particle, the Xi-zero or neutral cascade hyperon, has been discovered by a group of scientists at the University of California's Lawrence Radiation Laboratory. The Xi-zero particle, with a mass about 40 per cent greater than that of a proton, has zero electrical charge and exists for only a few billionths of a second. When it decays, it disintegrates into two zero-charged products. Since these primary decay products are electrically uncharged they cannot be directly observed in the laboratory. Their existence and the existence of their parent, the Xi-zero particle, can only be inferred from the presence of its products. The Xi-zero particle completes the list of the currently predicted set of particles of ordinary matter. A few predicted anti-particles have not been detected.

The particle was discovered by means of the laboratory's 15 in liquid hydrogen bubble chamber, an instrument used to photograph charged particle tracks. The bubble chamber was exposed to a special beam of particles produced by the Lawrence Radiation Laboratory's bevatron. The Berkeley scientists found only one photograph (out of a series of 70,000 taken during experiments) with evidence of the creation of the Xi-zero. Experimental evidence of this particle provides a basis for greater confidence in present theoretical interpretations of the nature of matter.

Hydrogen Bubble Chambers

Speaking at a meeting of the Physical Society Low Temperature Group on 15 January, Dr. N. C. Barford outlined the use of hydrogen bubble chambers and discussed problems associated with them. Although many liquids may be used to give bubble tracks of ionising particles, liquid hydrogen is the most valuable to the nuclear physicist. The rapid cycling rate of the hydrogen bubble chamber together with its high density of unadulterated protons enables efficient use to be made of the large output of particles from high-energy accelerators. At the same time multiple scattering of particles in liquid hydrogen is sufficiently small for accurate momentum measurements to be made with magnetic fields of reasonable strength. Unfortunately, the physical properties of liquid hydrogen make it a very difficult liquid to use. The problems may be grouped into those concerned with the physical properties of glass and metals at low temperatures, the expansion system for producing superheat in liquid hydrogen, optical arrangements for photographing tracks, low-temperature control systems and safety devices.

Submarine Reactor

The keel of Dreadnought, Britain's first nuclear submarine, is to be laid this summer. The reactor plant to be installed is similar to that in the United States' 2,700 ton nuclear submarine Skipjack and will be supplied under an agreement between Rolls-Royce and the Westinghouse Electric Corporation. Vickers-Armstrongs (Shipbuilders), who are building the submarine and installing the machinery, are to exchange information with the Electric Boat Division of General Dynamics Corporation, who built the Skipjack.

German Contract Lost

It is reported that all three British tenders for a 100 MW nuclear power station have been rejected by a Baden-Württemberg study group. They are now considering three American tenders. The British tenders have been submitted by NPPC, AEI-John Thompson, the group including English Electric, and GEC—Simon-Carves. The American tenders are from Westinghouse, Babcock and Wilcox (USA), and Atomic International of North American Aviation. A tender from the American General Electric Co. has been rejected. Reasons given for rejection of the British tenders are higher cost of installation, less favourable terms for the supply and return of fuel, and the United States loan under the Euratom agreement. For overall German nuclear power programme see Atomic Review on 2 January this year.

Chapelcross Feeds the Grid

Scotland's first nuclear power station at Chapelcross, near Annan, Dumfriesshire, is now operating, and will be officially opened on 2 May. Last month, the first of the four reactors came into use for electricity generation. As reported in Atomic Review, the reactor went critical last November, and has now concluded its testing and commissioning period. With the completion of the steam circuit and turbo-alternator the steam, which had previously been passed to a dump condenser, can now be fed to the turbine. The programme required electricity generation to start on 1 March.

The Chapelcross station, which will have a generating capacity of 184 MW and will, when all four reactors are completed, feed about 140 MW to the National Grid, has been built by the United Kingdom Atomic Energy Authority as a dual purpose station to provide plutonium and electricity. The construction of Chapelcross is under the control of Merz and McLellan, acting as agents for the Atomic Energy Authority's Industrial Group, the first occasion on which a private firm has been employed in this way on a major project.

Thermal Rating of British Power Reactors

The mean thermal ratings in MW per tonne of uranium of existing and projected power reactors in the United Kingdom are listed below, together with that of the Latina station being built by the Nuclear Power Plant Company. Windscale (UKAEA) 0·75; Calder Hall and Chapel Cross (UKAEA) 1·4; Bradwell (NPPC) 2·10 (peak 3·65); Hunterston (GEC—Simon-Carves) 2·16; Berkeley (AEI—John Thompson) 2·4; Latina (NPPC) 2·5; Hinkley Point (English Electric—Babcock and Wilcox—Taylor Woodrow) 2·6; and the Advanced Gas Cooled Reactor (UKAEA) 7·75 (peak 18·00).

Automobile Engineering

ROAD RESEARCH IN THE USA

An encouraging statement on the progress being made in the United States in the reduction of road accidents is published in the September issue of *Traffic Engineering*, the journal of the Institute of Traffic Engineers. The author, Mr. K. A. Stonex, begins by noting the tremendous volume of road traffic in the United States: in 1957, 650,000 million miles were run by some 66 million vehicles, an average of 10,000 miles each. Death and injury on roads is "a major social problem," but Mr. Stonex points out that the fatality rate has decreased steadily from the time that records were first kept. From a rate of 18 per 100 million miles in 1925 it has fallen to slightly below six for 1957.

Mr. Stonex suggested that there was "no component of the vehicle which is not susceptible to improvement as better materials become available and manufacturing techniques developed further." But, he added, "the modern automobile is a safe, reliable, dependable vehicle." One of the improvements he singled out was the introduction of the dual-lamp system of lighting in 1957. Driver errors account for most accidents: Mr. Stonex suggested that "a most fruitful research would be to determine the accident causation factors in human behaviour," and that this might be studied best by the methods of operations research. But Mr. Stonex suggested that experts already know "more about the solution of traffic problems than they can persuade the public to accept."

The striking conclusion reached was that a determined application of existing knowledge and availability of funds could reduce deaths to a negligible number and improve mobility on the roads to any degree selected. Mr. Stonex would have a ready and most attentive audience in this country.

ELUSIVE TURBOCAR

The marked lack of enthusiasm on the part of car manufacturers for the gas-turbine as the power unit of the future may not last much longer. The *Bennett Report* (vol. 2, March, 1959) reviews the development of the gas-turbine since it was predicted in 1908—by a staff writer of the *Motor*—that it would be perfected as a car engine within 25 years. Successful as the gas-turbine has been as an aircraft engine over the past decade, it has, the report states, "been kept under wraps by the automobile industry." Despite Rover's tests in 1952, and the success of several car manufacturers' experimental models, it is not yet in production. Manufacturers are concentrating their attention on new diesels and improved petrol engines, including an all-aluminium petrol engine.

The first break in the industry's indifference to the turbine principle was an announcement by Chrysler that one of their experimental turbo-powered cars had averaged 19·39 miles per gallon of diesel fuel on a run between New Jersey and Toledo, Ohio. Excessive fuel consumption has been the most general criticism of the gas-turbine so far. Ford, General Motors and several other manufacturers in the United States and in Europe, are also experimenting with turbocars, and there is no doubt that considerable progress has been made in adapting the turbine principle to the needs of the motorist. Inco Nickel have, in an advertisement, called the gas-turbine "power packed," describing it as "having fewer parts, no pistons, no water systems, only one sparking plug and being able to run on low-grade fuels." As fuel consumption improves further, comments the *Bennett Report*, gas-turbines will become a more important factor in the automotive industry. The improvement in highways and the growing need for fast freight haulage are factors in its favour. But, it concludes, "whether the turbine will be able to catch up the gasoline and diesel engines remains to be seen." For cars it may well take another 25 years.

DISC BRAKE STORY

Under the title "The Power to Stop" Dunlop have produced a film showing the development of disc brakes and their contribution to road safety. The producer was Mr. Ronald H. Riley, in association with the Film Producers' Guild. The film, which runs for 21 minutes, shows the company's contribution to the development of disc brakes from their origins in the field of aviation to their subsequent development for use on racing cars, high speed production cars and heavy road vehicles. It is available in 16 mm black and white film from the Dunlop Film Library at Wilton Crescent, Merton Park, SW19.

NEW CARS IN ACCIDENTS

New cars more than old ones are wrecked in collisions in South Carolina, USA. An analysis of accidents within the State during 1957 published in the September issue of the Bulletin of the American Association of Motor Vehicle Administrators reveals that 9,802 vehicles one year old or less and 6,771 vehicles one to two years old were wrecked. No other age group produced as high a number of accidents. The next highest was the seven-year-old group, which produced 5,949 accidents, followed by four-year-old vehicles with 4,874. A total of 251 people died in vehicles two years old or less.

The summary notes that approximately 82 per cent of all vehicles involved in 1957 traffic crashes in South Carolina were passenger cars—45,776 vehicles out of a total of 55,641 vehicles. Useful information which the survey does not give would be the length of time the drivers involved had been driving. It could well be that the "black" age groups of vehicles are those in which inexperienced drivers predominate.

QUIET HOLIDAYS ABROAD

British motorists are tending to go further and further afield in search of the quieter holiday centres of Europe. Portugal, Norway, Sweden, even Czechoslovakia and Yugoslavia are becoming popular touring grounds. To some extent this may be due to facilities for transporting car and passengers some of the way to distant objectives, but the love of motoring must play a big part. The attraction of uncrowded continental roads, of sunshine and the sense of adventure combine to make it a most attractive undertaking. The reliability of modern cars, and the extensive service facilities most British makers are establishing throughout Europe, help to make the trip not so hazardous as it might have been 20 years ago.

The latest issue of the AA *Foreign Touring Guide* reflects the trend. It contains detailed information about 19 countries and some 40 pages of road maps—eight more than last year's handbook. Those for Spain and Italy have been extended to take in the whole of these two countries as well as the holiday islands of Sicily, Corsica and Sardina. Portugal, Norway and Sweden are included for the first time and several other countries are covered in greater detail. Each country has its own section with details of hotels, garages, motoring regulations, geographical features, a brief historical background, gastromic guidance, Customs facilities, a mileage chart and even British hospitals. There are over 5,320 AA appointed hotels in the handbook—including 100 motels—and over 1,750 recommended garages. A currency conversion table and information about caravaning and camping, banking hours, golf courses and ferries are among other items in the guide. There are also full details of AA services abroad, including the Association's breakdown scheme.

MINX ON COBBLES

A gruelling test of a motor car ended recently when a Hillman Minx completed 25,000 km (15,534 miles) of continuous motoring at an average speed of 41 m.p.h. Rootes selected the circuit with care—paved all the way with what is described as "the brutal Belgian cobblestones," with "a cruel camber and hundreds of potholes." The route led through the outskirts of Brussels and Antwerp out into the open country, through villages and farmyards and over a dozen railway crossings and swing bridges. Conditions were much worse than had been anticipated, with snow, mud, black ice and fog. Only five laps had been completed before special steel-studded Dunlop ice tyres had to be fitted to keep the car on the black ice which formed over the pavé. Only women drivers were used throughout, led by Miss Sheila Van Damm. Others in the team were Mrs. Nancy Mitchell, Miss Mary Handley Page, Mrs. Francoise Clarke and Miss Pat Ozanne—all experienced rally drivers.

The test was designed to demonstrate how well a standard production car would stand up to conditions far worse than anything ever conceived before. The British Motor Industry Research Association say that 1,000 miles over the notorious Belgian pavé equals the punishment received by the average European car during its lifetime, and it is problematical whether the average lightweight European car would stand even that at such speed without falling to pieces. To drive this point home and to prove that all was outstandingly well, Miss Van Damm did the last lap at an average speed of just under 50 m.p.h.

BMC WIN AT SESTRIÈRE

The three cars entered by the British Motor Corporation in the 10th International Rally del Sestrière each won a major prize. They also won the team prize. The Sestrière Rally is an annual event in Northern Italy run over 1,800 miles of roads, including hill climbs. Speed trials are scheduled at Modena and Turin and a final test consists of a fast reliability trial of two laps of the snail-shaped Sestrière circuit.

Pat Moss and Ann Wisdom, the 1958 European Lady Champions, took the top ladies award in a Riley 1·5 winning the Coppa Delle Dame and the Coppa Club Torino. This is their third major success this season, following the Coupe des Dames in the Monte Carlo Rally and the Ladies Cup in the Canadian Winter Rally. Tommy Wisdon drove the Austin Healey Sprite to first place in the Grand Touring Car Class (500 to 1,100 cc) and John Sprinzel and S. Turner came third driving an Austin A35.

Marketing

Encouraging Breakthrough

An all-out attempt is being made to sell a British designed aircraft in the United States, with considerable promise. The Hawker Siddeley Group announced recently that a provisional order for the Argosy freighter had been signed between Riddle Airlines Inc. of Miami, Florida, and Sir W. G. Armstrong Whitworth Aircraft, who designed and built the Argosy (AW650). Arrangements are being made for demonstration aircraft to be available to Riddle Airlines for route proving flights.

The Argosy, a pressurised turbo-prop freighter-coach, is powered by four Rolls-Royce Dart engines, and has a cruising speed of 300 m.p.h. Riddle Airlines, who are the fifth largest all-freight operators in the United States, will be the first airline to put turbo-powered all-cargo aircraft into operation. Their president, Mr. George L. Giles, praised the aircraft for the quality of its design as a cargo carrier, stating that "Apart from its lower direct operating cost, the Argosy will benefit the indirect expenses due to lower handling costs. This is recognised as being a prime factor towards the successful air cargo operation. The AW650 is the first aircraft to be designed and produced with this in view.

With minimum reorganisation, the Argosy's quick loading and turn-round will save us at least 20 per cent on handling alone."

Route studies indicate that the Argosy is 30 per cent more economical to operate than the C46, which constitute the bulk of Riddle Airlines' present fleet (they own 32 C46 and 3 DC4 aircraft). The versatility of the Argosy has doubtless a strong appeal to mixed operators: its full width freight door at each end enables easy loading of up to 13½ tons of cargo; alternatively, it can carry up to 80 passengers in pressurised comfort or a mixed load of freight and passengers. The new aircraft will make its first public appearance at the Paris International Air Show in June.

Lisbon Fair

Bookings for the British Trade Fair in Lisbon (29 May to 14 June) have exceeded the best hopes of the organisers. The products of some 360 British manufacturers will be on show and about 150 firms have booked their own stands. The long list of exhibitors includes most of the leading exporters in British engineering, with a strong representation from the motor vehicle industry—including ACV, Austin, Ford, Jaguar, Joseph Lucas, Rolls-Royce and Standard Motor Company.

The Birmingham Engineering Centre, who reserved two areas totalling about 770 sq. ft, have organised a group stand at the request of the Federation of British Industries. They hope that 33 firms will take part who might otherwise have been unable to exhibit at Lisbon. By mid-February, when every square foot of space in the exhibition hall had been taken up, the BEC still had room for 24 exhibitors and they hoped that firms who could not get individual space, or who wished to take advantage of the organisational and administrative facilities offered by the Centre, would join in their scheme. The outstanding success of the BEC's stand in the British Industry Pavilion at the Brussels Exhibition should provide a strong incentive to many more firms than can be accommodated.

Soviet Export

Few people can be aware of the attractive—and informative—publications by Soviet *bloc* countries on their export industries. Two of the latest to reach this office are particularly interesting, and a useful reminder of the mounting effort of Soviet Russia and Czechoslovakia in export markets.

Soviet Export, dubbed "a quarterly advertising review," is a 52 page large format publication which contains 14 articles on Russian manufactures, most of them engineering goods. Mining plant, pumps, tractors, transformers, mobile power plants, measuring instruments, electronic engravers, cameras and bicycles are among those described in some detail and illustrated mainly with application photographs. The whole effect is that of an arts magazine about capital equipment. An article on mobile drilling rigs shows that simple but effective equipment has been developed which will doubtless have its appeal in any country where rugged design and simplicity of operation command a premium. The information on how components are packed is unusual but most useful to would-be importers.

The FT Magazine, on Czechoslovak foreign trade, is perhaps more ambitious in the subject matter it carries—ranging from heavy plant to women's fashions. A number of articles on the country, its customs and its imports suggest that an attempt is being made to win tourist traffic from the West and to establish Czechoslovakia as a centre of European trade. Considerable space is given to various trade fairs and exhibitions, particularly the Brno Trade Fair which is being held next September. The fair will be concentrated on engineering and allied products, in 65,000 sq. metres of exhibiting space.

Europak 1959

Preliminary statements covering the fifth International Packaging Exhibition (to be staged at Amsterdam from 21 to 28 April) suggest that it will be of considerable technical interest and well attended. The exhibitors talk of "the rapid development of Europe's packaging industries, and the current blurring of national frontiers," which has made Europak a useful barometer of world interest in packaging.

Britain, Germany and the United States provide the bulk of the overseas participation, with between them a total of nearly 200 firms represented. The British packaging industry, under the guidance of the Board of Trade, is organising a large collective stand in support of the many individual exhibits from the United Kingdom. This is the first time that the industry has acted in this way and is most encouraging, particularly in view of the considerable stiffening in competition expected from Germany and elsewhere. In spite of what the exhibitors call a noticeable "exhibition fatigue" on the part of German machinery manufacturers, the number of German machines on show will exceed the number shown at the fourth Packaging Exhibition by more than 50 per cent.

The exhibitors' final comment is worth noting: "as Europak 1959 takes place at a time when the Dutch tulip fields will be in full bloom, here is another pleasant opportunity for those who will want to enjoy a uniquely colourful display when their day's work is done."

Automatic Selling

The point rammed home by a visit to the International Automatic Vending Exhibition (held at the Old Hall of the Royal Horticultural Society from 2 to 5 March) is that developments are succeeding each other with lightening speed in the field of automatic selling and that there will be many contestants for what promises to be a highly competitive race.

So far, the most successful firms have been those who market a range of vending machines handling confectionary and tobacco products. Major developments, however, have been in the automatic vending of drinks. Joseph Sankey's packaged milk and fruit drinks have sold over 1,000 of their "Vendo" machines in their first year (1958). A number of machines dispensing drinks, hot or cool, has greatly increased during the last few months. Most of these, such as the Apco machines distributed in the United Kingdom by Bramigk and Company, the tea, coffee and chocolate dispensers made by W. M. Still and Sons, Ditchburn Vending Machines' Hotspa and Colespa, the hot and cold drink dispensers of Berend Automats, and many others are either made here under licence or imported. In nearly every case the country of origin is the United States, or Western Germany, both coffee (or "coke") drinking countries.

Top Customer

During 1958, BP Trading Limited, the principal trading subsidiary of the British Petroleum Company, placed orders for materials, equipment and services to the value of £14·5 million. Shipments to overseas destinations, which accounted for 47 per cent of the total, covered some 22,000 consignments amounting to 124,000 deadweight tons, at a freight (air and sea) cost of just under £1·1 million. In addition, refineries and other main subsidiaries of BP in the United Kingdom placed orders valued at about £3·5 million to cover their local requirements. Orders valued at £500 and over were divided among approximately 420 British suppliers.

A new development in the distribution of petroleum products has taken place in Sweden. Coin-operated self-service pumps have been installed at a number of BP service stations and are proving popular with owners of motor scooters, mopeds and other two-stroke vehicles. By inserting one Krona into a slot in the pump the customer can help himself to a certain quantity of petrol and oil mixture.

Another Intruder

American manufacturers of heavy electrical plant have lost another home order to a foreign firm, on price. The City of Los Angeles awarded a contract for the supply of two generators to Brown Boveri Corporation who were the lowest bidders. Their quotation for the two 200 MW machines to be installed in a new power plant at Long Beach totalled £3·3 million. The lowest bid by a United States company was by General Electric who quoted £5·27 million. Second lowest to Brown Boveri were English Electric with £3·44 million, followed by Metropolitan-Vickers (£4·01 million) and C. A. Parsons and Company (£4·10 million).

The wide differences in the bids of European and United States firms suggest that the latter cannot be even remotely competitive in the field of heavy machinery. There is less and less opposition on the part of United States operators to the award of major contracts to foreign companies and a gradual squeeze out of all the local heavy electrical industry seems inevitable.

Research and Development

INDUCTION RAMMING OF RECIPROCATING ENGINES

Increasing Power Output of Internal Combustion Engines

By T. J. WILLIAMS, M.SC. PH.D.

Reader in Mechanical Engineering, University of London, King's College

IT IS well known that the volumetric efficiency, and hence the power, of reciprocating engines can be greatly influenced by induction pulse ramming. In this investigation, an attempt has been made to supplement existing experimental information on this subject and to develop a simple theory to analyse the results so as to give some indication of the engine speeds and induction pipe lengths at which good and bad conditions can be expected with single-cylinder engines.

APPARATUS

The engine used was made by Russell, Newbery and Company Limited, of Dagenham, and was of the single-cylinder four-stroke compression-ignition type. The cylinder was of $4\frac{1}{8}$ in bore, the piston stroke 6 in, the inlet port diameter 1·64 in, the valve lift 0·38 in, and the speed range 300 to 1,400 r.p.m. The valve timing in degrees crank angle after TDC was:

IVO	353°	IVC	212°
EVO	135°	EVC	10°

It was decided to use a compression ignition engine in preference to a carburetted engine in order to avoid any restriction in the inlet duct. The induction pipe was of $1\frac{3}{8}$ in bore, and the pipe lengths varied from 6 to 22 ft. Throughout the tests the jacket cooling-water outlet temperature and the output torque were maintained constant.

A direct displacement method described elsewhere[1] was used for measuring the air flow to the engine. In order to compare the results obtained with and without induction ramming, a parallel series of tests was conducted with a damping tank of about 10 cu. ft capacity inserted in the induction duct near the inlet ports. The same system of piping and capacities was used between this latter tank and the metering tank as in the ramming trials, thus ensuring the same resistance to air flow. The results are expressed as the ratio of the flow with and without ramming, this ratio being plotted against the frequency ratio, q, of the natural frequency of the induction system to the frequency of the inlet valve.

High Speed Tests.—The engine tests outlined above corresponded to values of q within the range $q = 1$ to $q = 13{\cdot}5$. Theoretical considerations suggested that it would be of interest to extend the results to lower values of q—corresponding to higher engine speeds for a given induction pipe length. Since the author did not have a suitable high speed engine available, it was decided to simulate the pulsations in the induction system of such an engine by drawing air through a rotary interrupter valve consisting of a cast-iron rotor with a rectangular slot cut through it and a stationary outer sleeve in which openings of various shapes were cut.

In this way it was possible to vary the opening period of the valve, and also to modify the valve-area against rotor-angle curve. Two valves were used. In one of these the period during which the valve was open was equal to that during which it was closed, and in the other the ratio of the open to closed periods was 1 to 3. It was expected that the induction system pulsation pattern would approximate to that of a single-cylinder air compressor in the case of the first valve, and to a four-stroke engine with the second. The rotor was directly coupled to a d.c. motor with a maximum speed of 5,000 r.p.m., this giving equivalent compressor speeds up to 10,000 r.p.m., and equivalent four-stroke engine speeds up to 20,000 r.p.m.

The Russell, Newbery engine was used as a pump to suck air through the equivalent of an induction pipe and the rotary valve into a 64 cu. ft damping tank, the engine being governed to run at a constant speed during the test. Readings of valve speed and tank vacuum were noted. The "induction" pipe was then removed and readings of valve speed and tank vacuum again taken in order to estimate valve resistance. Since it was desirable to relate the tank vacuum to the flow, tests were carried out using the direct displacement method for metering the flow, the tank vacuum being adjusted by using the rotating valve as a variable throttle. Results were again expressed in terms of the flow ratio with and without pulse ramming.

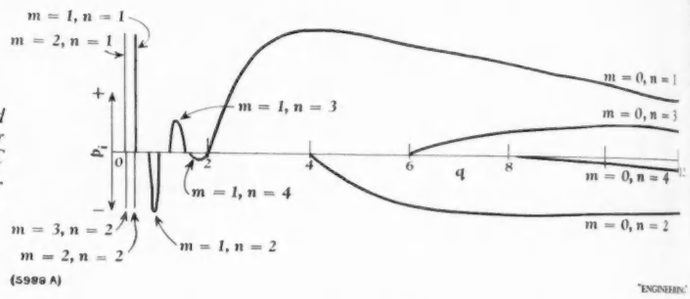


Fig. 1 Predicted duct pressures near inlet ports at ODC of suction stroke.

THEORETICAL CONSIDERATIONS

In the case of a single-cylinder four-stroke engine, the frequency ratio, q, is given by $30\,a/\mathrm{N\,L}$, where a is the acoustic velocity, N the engine r.p.m., and L the length of the induction duct. One of the earliest attempts to examine the theory of induction system pulsation was due to Capetti,[2] who gave $\mathrm{L} = 7{\cdot}5\,a/\mathrm{N}$ as the most favourable length of induction duct, this corresponding to a value of q equal to 4.

Experimental investigation showed that optimum volumetric efficiencies occurred at other values of q, and in the course of a more elaborate analysis, Morse, Boden, and Schecter[3] concluded that favourable pipe resonances could be expected near $q = 3$, 4, and 5, but at no other values of q. An attempt was also made by the authors to predict the form of the volumetric efficiency against frequency ratio curve for a given engine running at constant speed, and a fair degree of success was obtained between $q = 3$ and $q = 7$. Taylor, Livengood, and Tsai[4] have also predicted theoretically the form of these curves. Solutions in this case were obtained using a high speed electronic computer. Such an elaborate method would be difficult to justify in general since it would be necessary to derive a separate numerical solution for each engine design, induction system and engine speed. In the present paper, a very simple—and of necessity very approximate—analysis based on wave action in the induction system has been undertaken in order to predict the ranges of q in which good and bad volumetric efficiencies can be expected, it being contended that the final adjustments to determine the optimum pipe length are best carried out on the engine itself by trial and error.

In this analysis it is assumed (*a*) that the piston generates a sinusoidal suction pulse of half period equal to 180° crank angle, (*b*) that this generated pulse is in no way affected by the pulsations in the pipe, (*c*) that effective inlet open and closed correspond to IDC and ODC respectively, (*d*) that the pulsations are propagated without distortion at acoustic velocity along the induction duct, and (*e*) that the pulsations are in no way changed by reflection at the

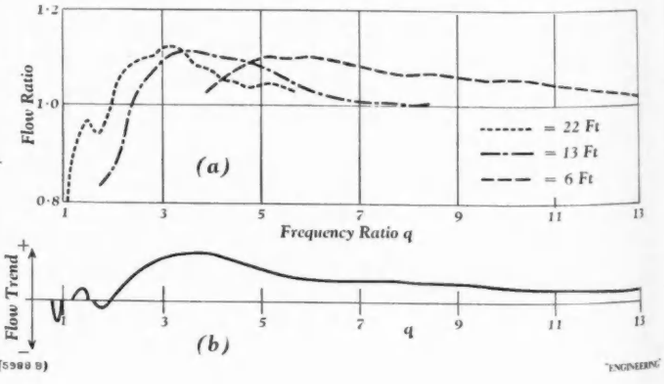


Fig. 2 (a) Flow ratio curves from engine tests. (b) Predicted trend curves.

valve ports. In order to take pipe friction and open end reflection losses into account, it will be assumed for the moment that the pulse amplitude is reduced by one half for each double traverse of the pipe. While it is freely admitted that the above assumptions make it impossible to claim any real quantitative value for the analysis, it is nevertheless hoped that the qualitative results obtained can be of value in interpreting the experimental evidence available.

The suction pulse gauge pressure can be expressed as

$$p = -\bar{p}\sin\left(2\pi\frac{t}{\mathrm{T}}\right) \quad . \quad . \quad (1)$$

$$0 \leqslant t \leqslant \frac{\mathrm{T}}{2}$$

where $\bar{p}$ is the maximum suction gauge pressure, t the time measured from the suction stroke IDC, and T the time for one revolution of the engine. A pressure point corresponding to the time t on this pulse will arrive back at the inlet port at the end of a suction stroke having made n double traverses of the duct if

$$(2m + \tfrac{1}{2})\,\mathrm{T} - t = \frac{2n\,\mathrm{L}}{a} \quad . \quad (2)$$

where $m = 0$ if the pulse arrives back at the end of the same stroke as that in which it is generated, while $m = 1, 2, 3$, etc., if the pulse arrives back at the ports at the end of the next or succeeding suction strokes. Since

$$q = \frac{30\,a}{\mathrm{N\,L}} = \frac{a\,\mathrm{T}}{2\,\mathrm{L}} \quad . \quad . \quad (3)$$

then eliminating L/a from equations (2) and (3),

$$\frac{t}{\mathrm{T}} = (2m + \tfrac{1}{2}) - \frac{n}{q} \quad . \quad . \quad (4)$$

From equations (1) and (4) and the assumptions stated above, the gauge pressure p_i at the inlet ports at the end of a suction stroke due to a returning pulse is

$$p_i = (-\tfrac{1}{2})^{n-1}\,\bar{p}\sin\left\{2\pi\left[(2m + \tfrac{1}{2}) - \frac{n}{q}\right]\right\} \quad (5)$$

where

$$\frac{n}{2m + \frac{1}{2}} \leqslant q \leqslant \frac{n}{2m}$$

If it is now assumed that the volumetric efficiency is directly related to p_i, we can obtain an indication of the variation in air consumption with q by plotting the pressure curves of equation (5) as in Fig. 1. Here the p_i curves are shown for $m = 0$, 1, and 2 and $n = 1$, 2, 3, and 4. The attenuated curves relating to higher values of n are neglected and the resultant flow trend curve obtained by combining the p_i values in Fig. 1 is indicated in Fig. 2(*b*). From these curves it can be seen that with the assumed degree of attenuation an increase in volumetric efficiency can be expected when q is greater than 2, the optimum value being in the neighbourhood of $q = 4$, higher values resulting in a gradual fall off in air consumption.

Where the degree of damping was less, other peak values would tend to appear in this range. For example, $m = 1$, $n = 6$ would produce a depresssion between $q = 2{\cdot}4$ and $q = 3$; $m = 1$, $n = 7$ a ramming pulse between $q = 2{\cdot}8$ and $q = 3{\cdot}5$; and $m = 1$, $n = 8$ a depression between $q = 3{\cdot}2$ and $q = 4{\cdot}0$. The result would be a peak in the flow trend curve at a value of q slightly greater than 3. A similar maximum could be predicted in the neighbourhood of $q = 5$.

From Fig. 1 it can be seen that poor values of the volumetric efficiency can be expected when q is roughly unity, this therefore being a region to avoid in practice. Below $q = \frac{1}{2}$ there are an infinite number of bands in which good and bad flow conditions can be expected, though this range has little practical significance.

In the above analysis it has been assumed that the suction pulse amplitude, $\bar{p}$, was independent of q. Where air flow curves are obtained at constant engine speed, this would be a reasonable approximation. In the case of flow curves relating to ducts of fixed length, however, the generated pulse amplitude would tend to increase with engine speed although there would also be a corresponding rise in the frictional attenuation associated with the higher air velocities in the induction pipe.

EXPERIMENTAL RESULTS

Engine Results.—Fig. 2(*a*) shows how the flow ratio for the Russell, Newbery engine varied with the frequency ratio q, in the case of three lengths of induction pipe, the engine speed range being 300 to 1,400 r.p.m. It will be observed that there is a reasonable degree of agreement between the predicted curve of Fig. 2(*b*) and the curve obtained with the 22 ft induction pipe. As the pipe length is reduced there is a shift to the right of the value of q corresponding to maximum volumetric efficiency. The results show, therefore, that factors other than q have an influence on the form of the flow ratio curves, this being in general agreement with the theoretical work of Tsai.[5]

If we assume that for a given pipe bore, friction is proportional to the length of the induction duct, L, and also to the square of the mean air velocity—which will be directly related to engine speed N—then, since q is inversely proportional to NL, friction is proportional to $1/Lq^2$. Thus at the lower values of q, attenuation effects would increase with a reduction in pipe length, and this would account partly for the fall off in the flow ratio below about $q = 3$ with the shorter pipe lengths in Fig. 2 (*a*).

Other factors which would tend to explain the differences between the flow ratio curves obtained are the effect of engine speed on the form of the generated pulse and the time available for the reflected pulse to influence the cylinder pressure. The latter consideration suggests that at high speeds the duct pressure near the inlet port at about mid-stroke would provide a more reliable flow trend indication than the pressure at ODC used in the above theory. If this were so, there would be a displacement of the flow trend curve of Fig. 2(*b*) to the right in the case of short pipe lengths, and therefore high engine speeds for a given value of q. Taking the pressure at mid-stroke as a guide to the volumetric efficiency, an increase in flow would be expected only if q were greater than 4, the optimum flow being predicted when $q = 8$.

Experimental results published by Taylor, Livengood, and Tsai,[4] Boden and Schecter,[6] and Kastner[7] were also examined in detail, the flow ratio curves being replotted against frequency ratio where necessary. The curves of Taylor, Livengood and Tsai[4] related to induction pipes of fixed lengths, the engine speed being varied over a certain range as was the case in the present work. The results showed a similar trend to those of Fig. 2(*a*) although the pipe lengths were in all cases less than those investigated here. The tendency for the flow ratio to fall below unity at values of the frequency ratio less than about 3 to 5 was noticeable with pipe lengths of 2 to 4 ft. This tendency was apparently less if the inlet valve were closed late, but no general conclusion could be drawn since absolute values of flow were not given.

Curves obtained at constant engine speed were given in references (6) and (7), the duct length being varied by adding short sections of inlet piping. In this case, frictional attenuation —which has been shown to be roughly proportional to $\mathrm{N}^2\mathrm{L}$, and therefore to N/q—varies with $1/q$ for a given curve, and therefore was not so important at the lower values of q as in the case of the constant pipe length tests where friction was proportional to $1/q^2$. Since the speed was constant, it could be reasonably assumed that generated pulse form remained the same, and the time available for charging was also constant for a given curve. It is not surprising, therefore, that the curves tended to maintain improved volumetric efficiencies as predicted down to $q = 2$, and provided that the pipe bore were sufficiently large, they also exhibited maximum peaks near $q = 3$, 4, and 5.

On comparing the results obtained using pipes of varying bores, it would appear that optimum performance was obtained when the induction pipe diameter was about half the cylinder bore. Too large a pipe bore reduces pulse amplitude, while too small a pipe bore results in serious wave attenuation. In the experiments reported in this paper the pipe bore was about one-third the cylinder bore.

Interrupter Valve Results.—The rotary interrupter valve made it possible to study simulated ramming effects at values of q well below those obtained in the engine tests. Another advantage of the results obtained by means of this device was that since the air flow was of the same order for all valve speeds during a given trial, and the pipe length was fixed, frictional attenuation tended to remain reasonable independently of the frequency ratio.

In determining the flow prediction curves for these tests, since the suction volume was constant, it was considered that at all valve speeds the duct pressure when the valve was fully open would give the best indication of the trend in the flow ratio, and the experimental results obtained did show a satisfactory degree of agreement with the predicted variation. The rather high resistance of the valve in which the ratio of the open to closed periods was 1 : 3 resulted in instability of the valve at certain speeds of rotation, but more satisfactory running conditions were noted with the other valve having an equal open and closed period.

A sample of the results obtained with the latter valve is shown in Fig. 3(*a*), the corresponding flow trend curve being shown in Fig. 3(*b*). The length of the " induction duct " in this case was 13 ft and the valve speed range 300 to 5,000 r.p.m., corresponding to a valve opening frequency of 600 to 10,000 per min. It was difficult to maintain steady valve speeds below

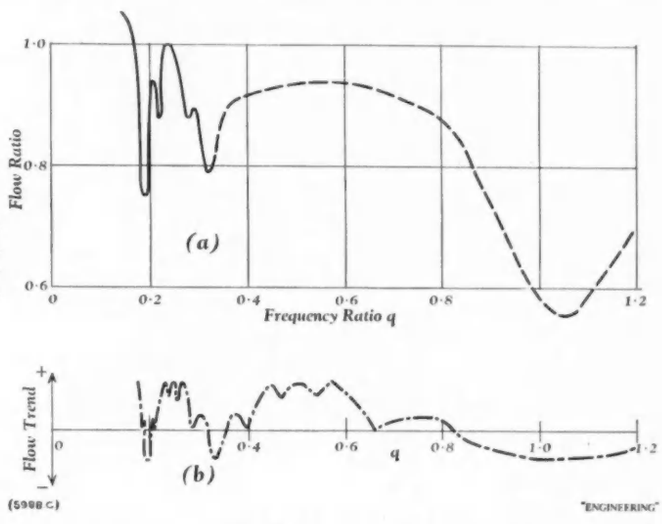


Fig. 3 (a) Flow ratio curve for interrupter valve. (b) Predicted trend curves.

Design

ANTI-VIBRATION MOUNTING FOR LOW FREQUENCIES

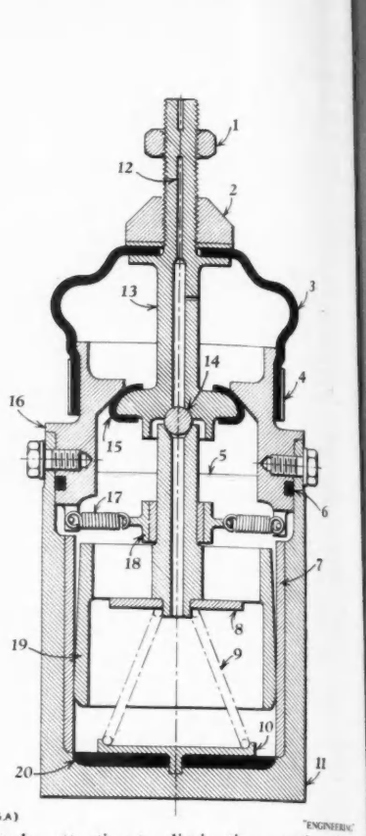
Low frequency vibrations arising from the excitation of the natural frequencies of panelled structures are a source of considerable trouble where high precision measurement and recording instruments and electronic apparatus are in use. A particular example—at first sight rather unexpected—has, in recent years, been encountered in the mounting of airborne cameras in high speed reconnaissance aircraft. Contrary to early expectations, isolating the cameras from vibration has proved to be far more difficult on jet-propelled than on piston-engined aircraft.

The problem of providing satisfactory camera installations on jet aircraft had in fact become so formidable by 1955 that the Ministry of Supply awarded a development contract for its solution to Fairey Air Surveys Limited, White Waltham, Berkshire. A search of the literature revealed that some fundamental experimental work would have to be undertaken before the problem could be solved; and a survey of commercially available vibration test equipment indicated that, for the range of frequencies concerned, Fairey would have to develop their own apparatus. In this article are described briefly Fairey's principal tools for low frequency vibration analysis, as well as two typical low frequency isolators developed by the company.

On the jet aircraft, the engine harmonics are no longer a major source of high amplitude vibration. On the other hand, the aerodynamic disturbances are far more severe for the modern high speed aircraft than they were on earlier reconnaissance aircraft. It is these aerodynamic forces which excite the natural frequencies of the fuselage panels, generally in the region of 4-10 c/s.

Vibrations in this range of frequencies are more difficult to isolate satisfactorily than are the medium and high frequencies associated with the engine harmonics, which had hitherto been tackled quite satisfactorily with the aid of proprietary anti-vibration mountings of solid or expanded rubber. As an isolating medium rubber has the advantage that it incorporates its own damping—important on an aircraft subject to high accelerations—but it has the disadvantage that, from batch to batch, its physical characteristics are not invariable, and therefore the provision of adequate mountings is inevitably a matter of trial and error. What really rules out rubber for low frequencies, however, is that its own natural frequency is too high to give any reduced transmission of motion unless an excessive volume of expanded rubber is used.

The isolators developed by Fairey, therefore, all depend on metal springs for the absorption of energy, and all are tailor-made for the particular application. Because low frequency isolators give essentially a soft suspension, some form of damping must be provided, and herein lies one of the difficulties in designing satisfactory mountings for aircraft applications. Enough damping must be provided to take care of the accelerations imposed in aircraft take offs, landing and manoeuvres; but if too much damping is incorporated, the isolating properties of the mounting at frequencies above its own resonant frequency will be reduced. There is also the difficulty of providing uniform damping over the wide temperature and pressure range encountered. For the more severe cases, Fairey have resorted to hydraulic damping, using silicone fluids which can be blended to give the required viscosity characteristic over the required temperature range. For less critical cases, friction dampers can be used. The use of metal springs has the advantage that analytical methods can be developed for the design of low frequency isolators.



Vibration isolator unit for a 170 lb camera. Four such units carry the camera cradle, and rapidly suppress any angular motion of the mounting.

1. Locking nut.
2. Locating cone.
3. Sealing bellows.
4. Bellows clip.
5. Oil level.
6. Sealing ring.
7. Bush.
8. Restrictor disc.
9. Spring.
10. Locating plate.
11. Body.
12. Air vent.
13. Top shaft.
14. Ball joint.
15. Bump stop.
16. Top cap.
17. Radial springs.
18. Centre bush.
19. Piston.
20. Bottom bump stop.

For photographic reconnaissance work the tolerances on angular motion of the camera are extremely small—in some cases, of the order of ½ min or less. In addition to suppressing linear vibrations over a much wider frequency spectrum then ever before, therefore, Fairey have paid particular attention to eliminating angular vibrations arising from out-of-phase motion of the support points; and to ensuring, should a small amount of angular motion be transmitted to the camera (it can, for example, be caused by operation of the camera mechanism) that it does not couple with the linear modes.

A typical vibration isolator unit designed for a 170 lb camera is shown opposite. The camera is bolted to a cradle mounted on four such units, and the complete mounting allows for changing the orientation of the camera and for fitting different lens-magazine combinations. This particular camera was one in which operation of the wind-on mechanism caused appreciable vibration, and the mounting has been developed to ensure that such vibrations are damped out before the next exposure is made, and that their amplitude is kept within specified limits (the

---

Concluding **Induction Ramming of Reciprocating Engines**

about 1,000 r.p.m., and the results for higher values of q—shown by a broken line—were not considered to be very reliable. For lower values of q it will be observed that there is a fair degree of agreement between the maximum and minimum of the flow curve and the predicted trend curve.

CONCLUSIONS

From the experimental results examined and the approximate theoretical treatment, it is evident that the volumetric efficiency of a reciprocating engine fitted with an induction pipe is not a simple function of the frequency ratio, q, alone. It is therefore not possible to make definite recommendations on the design of the induction system for a given engine, but the following observations relating to a single-cylinder four-stroke engine (where $q = 30a/NL$) may be of assistance in estimating the dimensions of a suitable ramming pipe.

(1) In the case of a long induction system—over 10 ft say—improved volumetric efficiency due to pulse ramming can be expected for values of q greater than about 2 to 3, the optimum flow being in the region of $q = 3$ to 4. This range would correspond to engine speeds below about 1,500 r.p.m. It should be remembered that there is a region of very poor volumetric efficiency at about $q = 1$.

(2) Where the engine is running at a constant moderate speed, maxima are usually observed in the flow curves near $q = 3$, 4, and 5, respectively, providing the duct bore is sufficiently large.

(3) In order to attain favourable ramming conditions at higher engine speeds it would be necessary to use shorter lengths of induction pipe. In this case there is a tendency for the flow curves to be displaced in the direction of higher values of q, as in Fig. 2(*a*), and for pipes less than about 6 ft long, increased volumetric efficiencies can only be expected when q is greater than about 4.

(4) From an examination of the experimental results available it would appear that the pipe bore should be approximately half that of the cylinder for best ramming results.

While the results obtained with the rotating valve tend to confirm the theoretical prediction that there are possible bands of good volumetric efficiency below $q = \frac{1}{2}$, this range would not in general have any practical significance since it would only apply in the case of very high engine speeds and/or very long induction pipes. In such a case frictional attenuation would tend to counteract any benefit due to pulse ramming.

REFERENCES

[1] L. J. Kastner and T. J. Williams, "Pulsating Flow Measurement by Viscous Meters, with Particular Reference to the Air Supply of Internal Combustion Engines," *Proc.I.Mech.E.*, vol. 169, pp. 419-444 (1955).

[2] A. Capetti, "Effect of Intake Pipe on the Volumetric Efficiency of an Internal Combustion Engine" (translation), NACA—TM No. 501 (1929).

[3] P. M. Morse, R. H. Boden and H. Schecter, "Acoustic Vibrations and Internal Combustion Engine Performance: I—Standing Waves in Induction Pipe Systems," *Journal of Applied Physics*, vol. 9, pp. 16-23 (1938).

[4] C. F. Taylor, J. C. Livengood, and D. H. Tsai, "Dynamics of the Inlet System of a Four-Stroke Single-Cylinder Engine," *Trans. ASME*, vol. 77, pp. 1133-1145 (1955).

[5] D. H. Tsai, "Effect of Size on the Inlet System Dynamics in Four-Stroke Single-Cylinder Engines," *Trans. ASME*, vol. 78, pp. 197-210 (1956).

[6] R. H. Boden and H. Schecter, "Dynamics of the Inlet System of a Four-Stroke Engine," NACA—TN No. 935 (1944).

[7] L. J. Kastner, "Induction Ramming Effects in Single-Cylinder Four-Stroke Engines," *Proc. I.Mech.E.*, vol. 153, pp. 206-220 (1945).

tolerances vary with the frequency and with the focal length of the lens in use).

Referring to the illustration, the top shaft is rigidly attached to the camera cradle. The load is transmitted through a ball bearing to a piston which is free to move vertically and to rock in its bush. Friction between the piston and bush is low, and contributes very little damping. The body of the isolator is filled with a silicone fluid which lubricates the sliding parts and provides the necessary damping. Vertical motion is damped by the flow of fluid through holes in the piston and by the viscous drag at the sliding surfaces. Horizontal motion of the aircraft relative to the camera causes the piston to rock, displacing fluid in the annular space between the piston and the bush. This provides horizontal damping.

Vertical loads are carried by a conical spring with stiffness approximately proportional to the load. Horizontal loads are resisted by a ring of small tension springs attached to a low-friction bush which is free to slide on the piston rod. As the piston moves downward under increased load, the moment exerted by the radial springs is increased, giving some increase in effective horizontal stiffness at the ball joint. The air space above the silicone fluid is sealed by a rubber bellows provided with a small pressure-equalising vent. The working clearances of the sliding parts of the isolator are held to close limits and are adequate to ensure that no damage occurs due to thermal contraction. The rubber parts are not damaged by silicone fluid or by temperatures down to $-60°$ C.

Another low frequency anti-vibration mounting developed by Fairey Air Surveys, in this case for a delicate electronic measuring instrument installed in a military aircraft for a special mission, is shown alongside. The operating conditions were severe, but fortunately there were no restrictions on space as is usually the case in aircraft installations. Both high and low frequency vibrations were known to be present in the aircraft concerned. Violent vibrations, both in the horizontal and vertical modes, with double amplitudes of 0·41 and 0·314 in respectively, occurred at a frequency of around 6 c/s, associated with aircraft manoeuvres involving a downward acceleration of 2·86 *g*. To overcome the problem, the mounting was designed to have a resonant frequency of about 3 c/s, lower, it is believed, than that of any mounting previously used in an aircraft. The corresponding static deflection of the mounting is 1 in, giving, therefore, a deflection of approximately 2½ in under the maximum *g* loading.

A square frame forms the outer anchorage for eight tension springs arranged symmetrically round the electronic equipment and attached to it through brackets. This gives approximately constant stiffness for downward or sideways accelerations up to 2*g*, under which conditions good vibration isolation is obtained. At higher accelerations, restraining springs fitted to the corners of the mounting come into operation and increase the stiffness, and hence the natural frequency, of the system; but even under the most adverse conditions—which occur only for short periods during manoeuvres—a 60 per cent reduction in the amplitude of vibration is obtained. Small friction dampers, incorporating a large amount of play in the links, ensure that, while the large transient oscillations occurring at take-off and landing are damped out, the isolation of normal vibration amplitudes corresponds to that of an undamped system.

Fairey are now turning their attention to the development of mountings for standard electronic equipment in aircraft. The conventional practice is to mount each " black box " on its own rubber mountings, in standard racking. In aircraft subject to high *g* loadings, there is considerable doubt whether such mountings are in fact isolators, and much of the unreliability of airborne electronics in service may well be due to the fact that they are being shaken up beyond their designed vibration tolerance. Fairey Air Surveys believe that a better solution is to mount all the electronic units solidly on the racking and to mount the entire assembly on large effective isolators designed for the purpose.

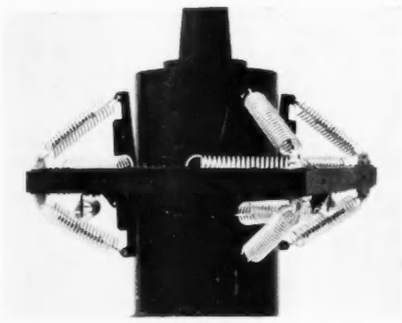
Turning now to the research and test equipment that has provided the data necessary for the design of the isolators, the main innovation introduced by Fairey is the direct measurement of displacement amplitude, as opposed to the more usual method of acceleration or velocity amplitude. By this means, static deflection, as well as dynamic displacements, can be measured. A small portable instrument embodying this principle, which is being made available commercially and which was on view at the recent Physical Society Exhibition, is a photo-transistor direct-reading displacement meter. In this instrument, a probe placed in contact with the component under test is used to interrupt a beam of light falling on a photo-transistor. The resulting signal, which can be fed either to a micro-ammeter or to an oscilloscope, is directly proportional to the displacement.

The laboratory vibration analyser, shown in the lower left hand illustration, has been designed for the accurate determination of load/deflection characteristics, resonant frequencies, damping coefficients, frequency and transmission characteristics of vibration isolators, in the ranges 0-500 c/s frequency, 0·001-0·1 in amplitude, and 5-50 lb load. The instrument has a linear response and provides a direct reading of amplitude and frequency throughout the range.

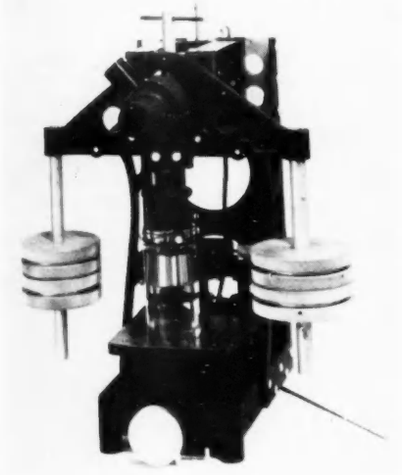
The vibration analyser is normally mounted on a vibrating table with the anti-vibration isolator or spring under test supporting the load-carrying beam of the instrument. The displacements of the table and the mounted load are converted by means of a photoelectric system into varying voltages which are shown on a double beam oscilloscope with a suitable time base. Mechanical linkages to the vibrating parts are thereby avoided. By calibrating the displacement of the beams of the oscillograph, the amplitudes of forcing vibration and transmitted vibration are easily measured at any frequency. The waveforms may also be studied. With the analyser mounted on an ordinary bench, and the pickup for the input or forcing vibration locked, the damping coefficient and natural frequency may be determined by observing the free vibration of the system after the load beam has been displaced slightly and then released.

For the final calibration of complete full-scale anti-vibration mountings, Fairey have built the test rig shown above designed to apply horizontal, vertical, or angular modes of vibration in the frequency range 0-500 c/s to the unit under test. The rig is isolated from the laboratory floor by a concrete raft on a 2 in cork mat separated from the main foundation. For measuring the angular displacement amplitude of the unit under test an optical method is used; a mirror mounted on the unit reflects light on to a photocell, the amount of light falling on the cell, which is used to generate a signal to an oscilloscope, fluctuating with the angular vibration of the specimen. The amplitude of the forcing vibration is measured by a photoelectric pickup similar in principle to that used on the vibration analyser.

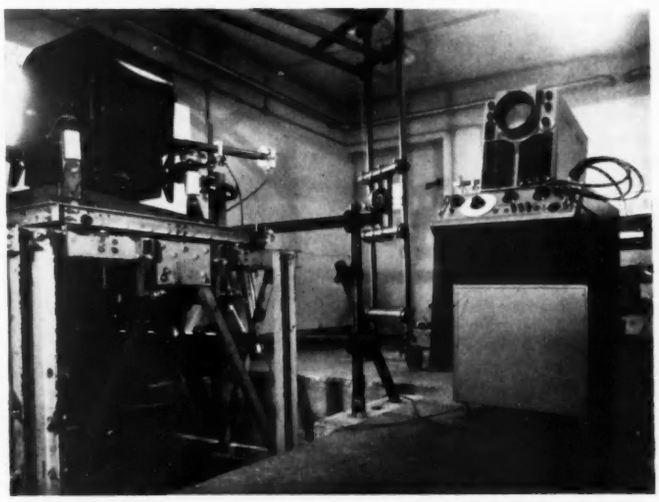
The direct reading displacement pick-ups with their high sensitivities, portability and simplicity, needing no amplifier circuits, are finding applications outside the vibration laboratory: for example, as the detector unit in a seismograph for the " on site " measurement of vibration in buildings; and for measuring the deformation of structures, railway lines, etc., under static or dynamic loads. The analyser has been used as a demonstration instrument in teaching vibration theory to engineering students. The low-frequency vibration isolators are being used to mount chemical balances, optical benches and sensitive instruments in modern steel frame buildings where structural vibration often occurs at low frequency.



An anti-vibration mounting with a natural frequency of 3 c/s, designed for a delicate airborne electronic measuring instrument.



Laboratory vibration analyser which indicates directly displacement amplitudes on a double beam oscilloscope.



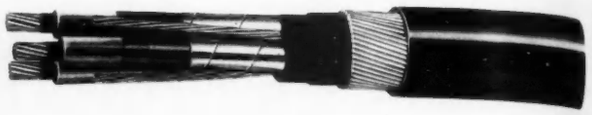
Test rig for applying horizontal, vertical, and angular vibration modes on complete anti-vibration mountings.

Continuing **Design**

ELECTRIC CABLE TO RESIST VIBRATION

Plastics Sheathing Chosen for Southend Pier

For their new pier installation, Southend Corporation recently decided to replace a lead/paper cable, which after giving good service for 25 years, had deteriorated through vibration, with the result that there was considerable inter-crystalline fracture of the lead sheath. Piers are subject to a large amount of vibration through the impact of ships when mooring, and Southend Pier, in particular, has an additional source of vibration in that it is traversed throughout its length by an electric railway. Engineers of the Telegraph Construction and Maintenance Company Limited (Telcon), Mercury House, Theobald's Road, London, WC1, do not recommend the installation of lead-sheathed cables on structures subject to heavy vibration, such as piers and bridges.



Three-core 11 kV polythene insulated and sheathed cable.

Southend Corporation decided, therefore, to use polythene insulated and sheathed cable manufactured by Telcon, an additional advantage of the polythene sheathing being its resistance to corrosion, rendering it eminently suitable for such a location as a pier. The final choice was a 0·1 in three-core 11 kV earthed cable.

Each core consisted of a conductor of 19 0·083 in plain copper wires lapped with two semi-conducting paper tapes, and insulated with polythene to a nominal radial thickness of 0·110 in. The core screen comprised a layer of Aquadag, one semi-conducting paper tape, and one 0·003 in copper tape. The cores were laid up with jute wormings and copper interstitial wires, lapped with one proofed tape, and served with a layer of compounded jute with compound over. Armouring was by 47 by 0·104 in galvanised steel wires, and the assembly was filled and sheathed with pvc compound to a nominal radial thickness of 0·100 in. A section of the cable is shown in the accompanying illustration.

In addition to the electrical tests to BS 480: 1954 (Impregnated Paper-Insulated Cables for Electricity Supply) made on the cable all the core was subjected to a special continuous discharge test as developed by Telcon. Approximately 2,400 yards of finished cable were required and were manufactured in two lengths, the longer about 1,840 yards, and the shorter some 560 yards.

The installation was carried out by Telcon construction engineers. The longer length, weighing some 10 tons, was mounted on standard jacks outside the entrance to the pier. It was hauled off the drum, laid on hangers and cleated over the esplanade under the pier in standard cleats, thence on to J-hangers along the station wall, and on to the walkway where it was laid over the cross-members of the pier. The shorter length was shipped from shore to pier in the Corporation's dredger. A straight-through joint was made on the pier employing hand-lapped plastics tape, and the joint was housed in a cast-iron box. The cable was finally terminated into switchgear in the pierhead sub-station and was then jointed to an existing PILC cable in the vicinity of the pier entrance.

HIGHER THRUST FOR ORPHEUS

Brief details have been released by Bristol Siddeley Engines of the Orpheus B Or 12 which represents the latest stage in the rapid and successful development of the " family " of Orpheus lightweight medium-thrust turbojet engines, and has been designed specifically to meet the requirements of advanced versions of such strike fighter aircraft as the Breguet Taon.

The first comprehensive bench test of this engine was successfully completed towards the end of last year—when the design thrust of 6,810 lb was easily achieved at design turbine entry temperatures, and specific fuel consumption proved to be considerably lower than had been predicted. The engine has a thrust/weight ratio in excess of 6 to 1. In addition, the engine has also undergone a 24-hour special category endurance test—and in " strip down" after the run proved to be very good indeed. Work scheduled for the coming year on this latest version of the Orpheus includes a 150-hour type test and also a full flight testing programme. At the present rate of progress, the engine could be available from the production lines by 1960.

Developed from the earlier Orpheus 803 of 5,000 lb thrust, the new engine has been designed for use in conjunction with a simplified form of reheat also made by Bristol Siddeley. This increases the maximum thrust by some 40 per cent to 8,000 lb, and is intended primarily for use at take-off to enable aircraft to operate from small temporary airfields.

Development of the Orpheus has been rapid. In little over four years, the thrust rating has been progressively increased from 3,285 lb to 8,000 lb. The current NATO engine, the Orpheus 803, which is rated at 5,000 lb, has the highest thrust/weight ratio for any type-tested engine in the world, and is now in quantity production for NATO forces.

Orpheus engines have logged over 17,600 hours' running on the test bed and in flight; they have flown in six different types of aircraft—the Breguet Taon, which holds the world's 1,000 Kilometre Closed Circuit Record, the Dassault Etendard VI, the Fiat G-91 NATO strike fighter, the Folland Gnat, the Lockheed JetStar utility transport, and the Japanese trainer aircraft, the Fuji TIF-2.

Altogether, the Orpheus has been specified as the power plant for 14 different aircraft. Licence agreements have been concluded with four countries: France, Italy, India and the United States.

The " static line retriever system " is designed to reel back into a Lockheed Hercules aircraft any paratrooper who gets entangled in the lines that automatically open his parachute.

RETRIEVING TANGLED PARATROOPERS

A life-saving device to pull a paratrooper back into the aircraft, should he become entangled in trailing static lines, has been developed by Lockheed Aircraft Corporation Los Angeles, California, USA, for its propjet military transport, aeroplane the C-130A Hercules. (Static lines are attachments in paratroop aircraft that automatically open parachutes as each is ejected from the aircraft.)

In the C-130A static line retriever system, as it is known, as each paratrooper bales out, the " jumpmaster " directing the operation watches the jumper's position in relation to the airflow and the trailing static lines. If a man becomes entangled in the lines, the jumpmaster hooks up the retriever cable, throws a toggle switch, and the man is reeled back.

Power for the retriever system is provided by two electrically-driven reversible winches. The jumper's static line is attached to the retrieving system through a thimble travelling on steel cable rigging which runs the length of the transport aircraft.

To avoid injuring the paratrooper when he is hoisted to the edge of the aircraft platform, the retriever cable passes over bars fitted with contact rolling surfaces.

Initial tests, using 400 lb dummies—more than the full weight of paratroopers equipped for action—proved the system's retrieving capability through all three of the C-130 Hercules jumpers' exits. The system, adaptable on both C-130 and C-123 aircraft, has also been operationally tested at Pope Air Force Base, North Carolina, by the USAF's Air Proving Ground Command.

Although accidents of the type that the new life-saving device has been designed to prevent are rare, one such accident occurred last year when a jumper was fatally injured during a routine C-123 mission.

TRAWLER WEIGHT SAVED BY DIESEL ELECTRIC PROPULSION

THE diesel-electric trawler Falstaff, built to Lloyd's highest class by Smith's Dock Company Limited, South Bank, Middlesbrough, to the order of Hellyer Brothers Limited of Hull, has recently completed her trials. She is the highest powered British-owned trawler, and is claimed to be one of the safest trawlers afloat, on account of increased freeboard.

Her dimensions are: length overall, 209 ft 6in; length B.P., 190 ft; breadth moulded, 34 ft 6 in; depth moulded, 17 ft 10 in. She has a bunker capacity of 201 tons and a fishroom capacity of about 18,250 cu. ft.

The advantages offered by a diesel-electric installation are in the weight of the machinery, the weight of bunkers required, the economic provision of power for the electric trawl winch, the direct control of the main engines from the bridge, and the fact that only one main generator need be run to provide sufficient power for trawling purposes. Compared with the traditional design of an oil-fired steam trawler, there is a considerable saving in weight, which was used partly to provide extra speed and partly to give an increased freeboard, thus improving the stability and safety of the vessel. The freeboard height when the vessel is returning in a loaded condition from the fishing grounds will be 4 ft 3 in. A further saving in weight was obtained by the use of mainly welded construction, and by eliminating the necessity of any cement ballast, in the design of the ship. Aluminium alloy fishboards are fitted throughout the fishroom thereby reducing the weight further.

The Falstaff is a deep sea diesel-electric trawler of 1,800 s.h.p.

Great care has been taken in the design of the Falstaff to reduce to a minimum the possibility of loss of stability while fishing in Arctic waters due to the formation of ice on the superstructure, rigging, and on sundry above-deck fittings. Wind areas of the deck-houses have been kept to a minimum; a bipod mast has been fitted, thus avoiding the necessity of fitting shrouds and stays which become solid with ice on normal trawlers; fishing gear has been fitted on the starboard side only; and all other outside fittings not essential to the working or safety of the ship have been avoided.

There is no entrance from the main deck to the after accommodation or engine room as access is by way of the boat deck, thus eliminating the possibility of water entering the deckhouse or casings from the main deck; and it is possible to move from the wheelhouse to any part of the after accommodation without going on to the exposed deck, by means of a passage constructed alongside the engine casings.

In accordance with modern trawler practice, lifeboats and all their heavy equipment have been dispensed with and self inflatable life-saving rafts have been fitted.

Fishing and navigational aids include the latest equipment for echo sounding and fish finding, comprising: two Marconi Fishgraphs, of the paper-recording type; one Marconi Fishscope; and one aural indicating Marconi Fishgong.

Long distance W/T and radar telephone communications are provided by Trans Oceania transmitter receivers and a Atlanta receiver. For short range work a Gannet transmitter/receiver is fitted for R/T communication on I/F bands. A " Mimco " broadcast receiver and remote loudspeakers with " talk back " facilities enables orders from the bridge to be relayed to and acknowledged from all working areas.

The diesel-electric machinery installation has been arranged and installed by the engine works department of Smith's Dock Company Limited, in collaboration with the English Electric Company, who supplied the main propulsion equipment. Power is supplied by three d.c. generators for propulsion and for the heavy winch load (300 h.p.), giving maximum flexibility and availability with light weight in a small space relative to the power.

The three main generators are installed abreast in the vessel. Each generator is powered by an eight cylinder English Electric CSRKM engine delivering 481 kW at 310 volts. Each engine is directly coupled to its main generator on the top of which is mounted a 60 kW 220 volt d.c. chain driven auxiliary generator. An unusual arrangement is that cooling air to the main generators is drawn from deck level and afterwards exhausted under the engine room floor. The temperature of this cooling air is controlled within limits.

Power is supplied to the propeller shaft by a single armature 850 volt d.c. propulsion motor, which delivers 1,800 s.h.p. at 175 r.p.m. This motor is totally enclosed and watertight to 2 ft above the shaft level; it is ventilated from deck level by Keith Blackman 2-stage axial flow fans, one working and one standby.

The propulsion motor can be controlled either from the bridge telegraph direct or from the engine room. The propulsion machinery operates on the controlled voltage principle, using Ward-Leonard control. The main generators and propulsion motor are arranged in a series circuit, so that one, two or three generators can provide propulsion power, and can be switched on or off without overloading the engines and without interrupting propulsion. A torque controlling rheostat is fitted so that the propulsion motor torque can be increased to compensate for the fall in propeller revolutions when the trawl is being towed, i.e., when propulsion power is being supplied by only one or two generators.

The " Robertson " electric trawl winch can be operated by any one main generator. All that is required is for the generator switch to be turned from either " propulsion " or " off " to " trawl," an interlock preventing more than one generator at a time being switched into the winch circuit. Since the winch characteristics differ from those of the propulsion motor, a separate exciter is provided to control the generator on winch duty.

LARGE TRANSFORMER BANK FOR SWEDEN

Installation Underground

Vattenfall, the Swedish State Power Board operating the country power grid, has ordered four 220,000 kVA transformers from the company Ateliers de Constructions Electriques de Charleroi, Belgium.

The equipment will constitute a three-phase 660,000 kVA transformer bank, probably the second largest in the world. The fourth transformer is a spare unit. The equipment is to be erected in an underground powerhouse hewn in solid rock near Vargfors, on the Skellefte Alv river.

Each shell-type transformer will have four windings designed for 400/149·5/13·7/13·7 kV transformation ratios. The transformers will be used simultaneously to raise the 13·7 kV alternators voltage to that of 400 kV of the power grids and to connect that 400 kV grid to another one, at 150 kV. Each of the 13·7 kV windings will receive the active and reactive powers from a 70 MW generator and from an 80 MVAR synchronous condenser.

The transformers will be tested under " chopped-wave " at 115 per cent of the contract values for full wave, and a transformer chosen at random will be subjected to impulse tests under record peak voltages of 1,650 kV " full wave " and 1,900 kV " chopped wave."

The weight of each unit, fully equipped with its cooling system (forced oil circulation into two water coolers), will be 210 tons, although for transportation requirements that weight will be reduced to 160 tons for the largest single package.

METAL SANDWICH RADAR AERIALS

The metal honeycomb sandwich construction developed by A. V. Roe and Company Limited, Manchester, for aircraft structures is now being applied to the manufacture of large radar aerial structures and reflector faces. This technique, it is claimed, ensures accuracy of profiles and shape, and since the aerial face can be used as part of the structure, results in a light weight component. The inherent stiffness of the sandwich construction enables the aerial to retain its shape to close limits in high winds; and, it is claimed, the fatigue properties are good. Both single and double curvature faces can be made with equal accuracy. A. V. Roe and Company have erected aerials with a face area up to 1,000 sq. ft, and have made detailed studies of aerials up to 3,500 sq. ft in face area.

Book Reviews

MEANING OF THE ACT

Industrial Law. By H. SAMUELS. Fifth edition. *Sir Isaac Pitman and Sons Limited, Pitman House, Parker Street, Kingsway, London, WC2.* (21*s*)

Coal Mining Law. By JOHN SINCLAIR. *Sir Issac Pitman and Sons Limited, Pitman House, Parker Street, Kingsway, London, WC2.* (50*s*)

The Legal Aspects of Industry and Commerce. By W. F. FRANK. *George G. Harrap and Company Limited, 182 High Holborn, London, WC2.* (12*s* 6*d*)

Few tasks are more difficult to fulfil than that of explaining a highly intricate and technical subject in terms that can be understood easily by laymen. It is doubly difficult to make such a book pleasant to read, particularly if the reader be a student. This double feat is what each of the authors of these three books have essayed.

Nowadays the law imposes extensive liabilities on employers in respect of their employees quite apart from those to be found in the common law of master and servant. Statutory provisions now affect wages and conditions of work, accidents and injuries, insurance and welfare schemes as well as the scope and activities of trade unions. Samuel's *Industrial Law* was written to provide those in industry and commerce who handle such matters with a general practical guide to the law on these subjects. It succeeds admirably in its aim: the book now in its fifth edition, is reasonably short, lucid and readable. Perhaps its chief virtue is that it strikes a balance between being too general on the one hand and too detailed on the other. The only omission to be noted is the absence of a table of abbreviations; not all readers can be expected to know what is meant by " 3 B. & C. 484 " or " 1 Ves. 48 "; a word of explanation, too, could hardly come amiss in this connection.

There has long been a need for a book in which the numerous aspects of law which concern coal mining were collected and collated and their meaning explained. Students entering the examinations of the Institute of Mining Engineers have particularly felt the lack of such a book. Professor Sinclair's purpose is to fill this gap and, in purely technical terms, he succeeds for all the main topics have been included in the text.

It is never an easy thing for an author to decide what to omit from a book of this kind, but there does seem to be little justification for devoting some fifty pages to a description of the legal system in England and Wales. This job has been done so much better elsewhere and the space could be better employed giving a fuller account of some of the formidable legislative provisions. The text would also be more easy to read if a consistent policy had been followed. Sometimes the regulations, which are numerous, are described in outline but not included, sometimes they are included in the text and annotated and sometimes included and not annotated. It would surely have been better always to have described the regulations in the text and let the appropriate regulations be set out in an appendix. All the necessary material is present but it is not very well organised.

The style is a little on the pedestrian side and too often long Latin words are preferred to short Anglo-Saxon ones and there is much space wasted on matters of no moment. In a chapter devoted *entirely* to the *Report of the Royal Commission on Safety in Coal Mines, 1938*, is it really necessary to say that " The report runs to 520 pages and is well worth study by all concerned with safety in coal mines "? But minor defects of style and presentation apart, this is a useful contribution to mining literature. It will be invaluable to practitioners for reference and of necessity will be used by students.

The same cannot be said of Mr. Frank's book. The task he attempts is one to make the boldest heart quail; for he trys to deal with at least a dozen major branches of the law in 220 pages. The book is very heavily written and suffers inevitably from over condensation; it gives the impression of short lecture notes that have been printed with the addition of some case summaries. Several different styles are employed and the manner is often rather condescending: " It will help in our discussion of bills of exchange if a draft of a typical bill is produced " or " You will appreciate from the examples why the law adopts this attitude." The real doubt raised by this book is whether a book so condensed as this is of much assistance to students; very brief summaries of technical matters are essentially hard to understand. What students need, like most of us, is something easy to understand.

F. H. B. LAYFIELD

RECUPERATORS AND REGENERATORS

Heat Exchangers: Applications to Gas Turbines. By W. HRYNISZAK. *Butterworths Scientific Publications, 4 and 5 Bell Yard, London, WC2.* (63*s*); and *Academic Press Incorporated, 111 Fifth Avenue, New York 3, N.Y., USA.* ($10)

Most gas-turbine engines, apart from those used in aircraft, require one or more heat exchangers. The heat exchanger may be essential to the operation of the engine, as in the closed-cycle gas turbine where a heat exchanger is the sole means of heating the turbine gas supply. More commonly, however, a heat exchanger is used to improve the performance of the engine by preheating the air from the compressor before combustion, making use of the turbine exhaust gases. The importance of heat exchangers in gas turbines which has been partly responsible for the enormous increase of interest in heat exchangers since the war and in heat transfer generally, is great enough to justify the appearance of the present book, which is devoted entirely to the subject of gas-turbine heat exchangers.

The author begins with an outline of the uses of heat exchangers in gas turbines and then distinguishes the two main types of heat exchanger, namely, the recuperator (heat transferred from hot fluid to cold fluid *through* a wall) and the regenerator (heat transferred by bringing heat transfer surface into contact with hot and cold fluids alternately).

Little mathematical knowledge, other than a knowledge of algebra, is required from the reader since the book does not deal with basic heat-transfer theory nor with the more difficult theoretical aspects of heat exchangers.

The next chapter is devoted to definitions of criteria for describing the performance of a heat exchanger and the following chapter deals with the influence of these criteria on engine performance. Unfortunately, little attempt has been made to relate the terminology to current usage and terms are sometimes introduced with insufficient clarity—for instance, the term " temperature efficiency " is introduced on page 33 and not until page 41 is the term defined. The intervening matter relates to compressor and turbine calculations and is irrelevant to the main subject.

Sections of the book are devoted to the design or recuperators, of both the tubular and plate types, and to regenerators. General design questions, such as calculation of optimum sizes, and detailed matters, such as the design of seals for rotating regenerators are both discussed. Other sections deal with heat exchanger materials, testing arrangements and economic aspects of design. Basic heat-transfer and pressure-loss data, however, does not receive very much attention though numerous references are provided.

The author is well known for his interest in gas-turbine heat exchangers and has presented several papers in the subject. The main aim of the book is, in his own words, " To support research, project and development engineers in their efforts to improve the different types of heat exchangers used in gas turbine units. . . ." In this aim he has succeeded in that the book goes some way to filling a gap in the literature and provides much useful information. One wishes, however, that greater care had been given to sifting and arranging the contents and to presenting the material with maximum clarity. An index is provided but it seldom leads rapidly to the information sought. " Heat transfer coefficient " gets a single page reference which turns out to be casual. " Mean temperature difference " and " thermal ratio " are not included.

J. R. SINGHAM

NEW BOOKS

Modern Road Emulsions. Third Edition. Edited by *The Technical Committee of Road Emulsion Association Limited, 47 Victoria Street, London, SW1.* (21*s*)

During the 20 years that have elapsed since the second edition of " Modern Road Emulsions " was published, general knowledge of bitumen emulsions has advanced considerably. Accordingly, in the present edition, the technical aspects have been given more prominence. Intended primarily for highway engineers, as a contribution towards economical and better road building and maintenance, it is also directed towards furthering the development of improved bitumen emulsions.

The Heat-Treatment of Steel. By EDWIN GREGORY and ERIC N. SIMONS. Second edition. *Sir Isaac Pitman and Sons Limited, Pitman House, Parker Street, Kingsway, London, WC2.* (35*s*)

This is the second edition of a well-known book, which first appeared in 1944 and was reprinted three times. New developments which have taken place since the first edition was printed, particularly in austempering and martempering, sub-zero treatment and in the new steels for the plastics industry, are dealt with in special new chapters. The book is written not only for the experienced heat treatment worker, but also for those to whom the subject is less familiar, and includes, therefore, explanations of why as well as how, things are done. It is well illustrated, and there is a good index.

Crushing and Grinding. A Bibliography. Published for the *Department of Scientific and Industrial Research by Her Majesty's Stationery Office, York House, Kingsway, London, WC2.* (35*s*)

There is an extensive literature on the subject of crushing and grinding, which are important operations in many industries, and this book collects together, with annotations, about 2,800 references. Arrangement is in nine groups dealing with every aspect of the subject, ranging from fundamental considerations to fire and health hazards. Nine short technical reviews, grouped as in the bibliography, preface the main body of the book. A name index as well as a subject index make it possible to refer quickly to any desired aspect.

DOSE CONTROL

Radiation Hazards and Protection. By D. E. BARNES and DENIS TAYLOR. *George Newnes Limited, Tower House, Southampton Street, Strand, London, WC2.* (30s)

Intended to provide a comprehensive survey of the potential dangers, precautions to be taken and methods of measurement associated with radioactivity, the material in this book is presented in a form which can be readily followed by those who have no previous knowledge of the subject. It will, however, be of interest to many who are already working in the nuclear field as the text contains a great deal of information not readily available from other sources.

The opening chapters describe the basic properties of radiation and radioactive materials and their effects on the human system, leading to the basis upon which maximum permissible levels of radiation are estimated. A valuable chapter on permissible doses summarises the current recommendations of the International Commission on Radiological Protection, which body is universally accepted as the authority in these matters.

Radiation shielding and general precautions to be taken when handling radioactive materials are treated in a practical way and illustrated by typical examples of laboratory layout and equipment. A substantial part of the book is devoted to detectors and associated instruments, and their application to radiation measurement. A chapter on the measurement of radiation describes the properties of ionisation chambers, proportional counters, Geiger-Müller counters and scintillation counters; a section on the characteristics of photographic film for radiation dose measurements is included in this chapter. There is a curious omission in the section dealing with Geiger counters, where the authors refer only to organic-quenched tubes which have a limited life. The halogen-quenched type of counter, however, has an indefinite life and is widely used, particularly in portable equipment.

A chapter on the fundamentals of instrumentation introduces the instruments required to deal with the outputs of the commonly used types of detector. The important features of a number of specific instruments are considered in six chapters which cover radiation dose and dose rate measurements, contamination monitoring, and airborne activity monitoring. The emphasis is upon the application of the instruments rather than upon the details of design. However, these chapters are illustrated by photographs and diagrams of instruments in current use, and give a useful account of their basic performance.

This is probably the most important section of the book, as everyone concerned with the nuclear field has at some time to use such instruments, and the correct interpretation of readings made with any instrument implies a reasonable appreciation of its characteristics.

Two chapters describe the application of laboratory techniques to the evaluation of radioactive samples (radioassay) and to the estimation of activity contained in the human body. The closing chapters which are of a more general nature deal with the problems of waste disposal, the transport of radioactive materials and the measurement of radiation from nuclear weapons.

An appendix gives a short list of the constants and formulae needed for the estimation of dose rates, effects of screening, and so on. The bibliography at the end of the book is short (twelve references), and is intended as a "library list" for those who wish to pursue further a particular aspect of the subject. Such a list of well chosen publications is perhaps preferable to the discouraging forest of specialist references so often to be found in technical books.

The authors state in the preface that they have endeavoured to write each chapter in such a way that it forms a self-contained essay on a particular subject, so that the book may be used as a work of reference. This has resulted in a certain amount of duplication, but the style is lucid, and for the most part the authors have achieved their object. A minor obstacle to ease of reading is a somewhat discouraging tendency towards the use of abbreviations, particularly in those sections dealing with dose rates and permissible levels of radiation; for example "R.B.E." for "relative biological effectiveness," "m.p.b.b." for "maximum permissible body burden." While these terms are in general use among specialists, and are defined in the text, their use will call for a certain amount of "hedge-hopping" on the part of the unsuspecting reader who is unfamiliar with the subject.

However, this does not detract from the value of the basic information, and the authors are to be congratulated upon producing the first coherent book on a subject of vital importance to every worker in the atomic energy field.

J. S. EPPSTEIN

The Reviewers

Mr. F. H. B. Layfield is a barrister at law and a member of the Town Planning Institute. As a practising barrister, he is mainly concerned with land and land law in its various forms on the one hand, and buildings and engineering contracts on the other. He is joint author of two works on the law and practice of town and country planning, and contributed to ENGINEERING in August to December 1956 a series of articles on "Engineering Contracts," which have since been reprinted.

Dr. J. R. Singham is lecturer in mechanical engineering at Imperial College, London, and was formerly with the National Gas Turbine Establishment and the Austin Motor Company. He is an A.M.I.Mech.E. and holds a Ph.D. and a B.Sc.(Eng.).

Mr. J. S. Eppstein, B.Sc., A.C.G.I., is project manager of Elliott Nucleonics Limited.

TRADE PUBLICATIONS

Copies of any of the following trade publicatons are obtainable from the addresses given, though distribution is sometimes restricted.

Sliding Doors. G. BRADY & CO. LTD., Manchester 4. Sliding shutter doors and gates, both solid folding panel types and grilles. Leaflet DG158 gives details.

Hardboard. WOOD FIBRE WALLBOARD CO. LTD., 8 City Road, Finsbury Square, London, EC1. Masonite Benelex dense laminated hardboards for many purposes. Range, characteristics and methods of working described in illustrated folder.

Toughened Glass. PILKINGTON BROS. LTD., St. Helens, Lancs. "Armourplate" toughened and polished sight glasses for all purposes. Leaflet E/8.

Stainless Steel Tube. MARKLAND SCOWCROFT LTD., Cox Green Works, Bromley Cross, Nr. Bolton. Stocks of stainless steel tube in various grades and sizes from $\frac{1}{4}$ in. to $6\frac{1}{8}$ in o.d. Leaflet.

Vertical Boilers. COCHRAN AND CO., ANNAN, LTD., Annan, Dumfriesshire. Oil and coal fired Class A vertical boilers from 150 to 10,800 lb of steam per hour. Up to 250 lb per sq. in pressure. Booklet No. 100 gives specifications and useful data.

On the Shelf

By Frank H. Smith

ASME'S *Mechanical Engineering* for February contains one or two noteworthy items. The editorial kicks off with three cogent rhetorical questions. "Your salary: Have you ever wondered how it compares with that of your fellow engineers? Do you often ask yourself 'Am I being compensated adequately for my job?' Or, 'Would I be better off salary wise in industry, education or government?'." Without being deafened by the chorus of Yesses to the first two or blinded by the highly illuminated question mark of the third, the editorial goes on to mention the Engineers' Joint Council's "Professional Income of Engineers—1958" at $3 from 29 West 39th Street, New York 18. When you have a copy you have the alternatives of flourishing it before your employer or hiding it from him—depending on how you happen to be placed.

The same issue has an article on the "Utilization of Waste Heat." This has a 60 item bibliography. Also a 1957-58 review "Progress in Railway Mechanical Engineering," which covers the world and doesn't seem to have a puff-puff in the lot. Belay that—one Beyer-Garratt for South Africa.

Space/Aeronautics is the new format version of *Aviation Age* and during the transformation it has acquired a form of index which can be cut out and pasted on to 5 × 3 cards. These give a code number, the title, an abstract, authors and origin. Quite useful. One article is "Astable multivibrator uses mesa transistors" and astable means "an astable multivibrator has two quasi-stable states and can switch from one to the other." Are you listening Oxford?

Wiggin Nickel Alloys celebrates its No. 50 by departing from the usual practice of articles describing specific uses of their products and describes, instead, the scope of the organisation and properties and applications of the alloys. There is also a postcard inviting application to visit private exhibitions showing the use of Wiggin Alloys in electrical and electronic engineering at Birmingham (24 to 26 March) and Manchester (20 to 22 April). Drop a line to Henry Wiggin and Company Limited, Thames House, Millbank, London, SW1.

British Petroleum are justly proud of the fact that five of their films, now on release, have been shown, altogether, to 26 million people. In 1958, films lent from their library were "screened" (Ugh !) over 25,000 times. A lot of times to go through a riddle.

Showing a commendable desire to interest themselves not only in their clients' work but also in their hobbies, five members of the Aslib Engineering Group toured Charrington's Anchor Brewery in the Mile End Road on the afternoon of 24 February. Apart from drinking a glass of wallop at the source (they could have bathed in it had they wished) and having a pleasant tea, they learnt a great deal about how the stuff finds its way from the grain to the bottle or barrel. Incidentally, the guide who took them round would not touch bottled stuff with a 40 ft barge pole. The secretary of the group gained considerable prestige by proving herself a tankard-type rather than "something out of a glass with a stem."

The University of Illinois Library School issues "occasional papers" which have now reached 53 (October, 1958). Its title is "Libraries in British West Africa" and is the record of a tour done by the author (H. Lancour) under the auspices of the Carnegie Corporation in October/November, 1957.

The North-Holland Publishing Company of Amsterdam announces a new quarterly "Journal of Nuclear Materials" at 130*s* a volume. There is an impressive editorial advisory Board at the top of which is a Mr. Aas of Norway. He should be somewhere near the top of any alphabetical list.

MEETINGS AND PAPERS

Association of Supervising Electrical Engineers

LONDON
"New Materials, Methods and Techniques in Electrical Engineering," by Dr. H. G. Taylor. Institution of Electrical Engineers, Savoy Place, Victoria Embankment, WC2. Tues., 24 Mar., 6.30 p.m.*

British Institution of Radio Engineers

LONDON
Symposium on "Radio Telemetry." London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 25 Mar., 3 p.m. and 6.30 p.m.
BRISTOL
"Recent Advances in Travelling Wave Tubes," by P. F. C. Burke. South Western Section. School of Management Studies, Unity Street, Bristol 1. Tues., 24 Mar., 7 p.m.

Building Centre

LONDON
Film: "Phoenix City," illustrating the use of Bowater Boards in the rebuilding of Coventry, exhibited by Bowater Paper Corporation Ltd. Wed., 25 Mar., 12.45 p.m.

Combustion Engineering Association

LONDON
"Costing of Heat and Power," by G. H. Buckle, at 10.30 a.m.; and "Capital Investment and Fuel Saving Schemes," by R. H. Potterill, at 2.30 p.m. Southern Region. St. Ermin's Hotel, Caxton Street, SW1. Tues., 24 Mar.

Engineers' Guild

BARKINGSIDE
Evening Meeting. South West Essex Centre. Doctor Johnson Hotel, Barkingside. Mon., 23 Mar., 8 p.m.

Illuminating Engineering Society

BRADFORD
"Fifty Years of Lighting Development, 1909-59," by J. W. Howell. Leeds Centre. Institute of Technology, Bradford. Tues., 24 Mar., 6.45 p.m.
LEICESTER
Discussion on Architectural Subjects. Leicester Centre. Offices of the East Midlands Electricity Board, Charles Street, Leicester. Mon., 23 Mar., 7 p.m.

Institute of Metals

SHEFFIELD
"Nimonic Alloys," by Dr. W. Betteridge. Sheffield Local Section. The University, St. George's Square, Sheffield 1. Thurs., 26 Mar., 7.30 p.m.

Institute of Petroleum

LONDON
"The Purpose of Additives in Modern Gasolines," by C. G. Tresidder. London Branch. Thurs., 26 Mar., 6 p.m.*

Institution of Civil Engineers

CHESTER
"Investigations of Navigation and Bridging Problems of the River Dee," by Professor J. A. L. Matheson. North Western Association. Queen Hotel, Chester. Thurs., 26 Mar., 7.30 p.m.

Institution of Electrical Engineers

LONDON
"High-Quality Microphones," by M. L. Gayford (in lecture theatre); and "Effects of Argon Content on the Characteristics of Neon-Argon Glow-Discharge Reference Tubes," by Dr. F. A. Benson and P. M. Chalmers (in tea room). Two separate simultaneous meetings of the Radio and Telecommunication Section. Mon., 23 Mar., 5.30 p.m.*
"Selection of Insulation Levels and Tests for High-Voltage Transformers," by G. B. Harper. Supply Section. Wed., 25 Mar., 5.30 p.m.*
BRADFORD
"Fifty Years of Lighting Development, 1909-59," by J. W. Howell. North Midland Centre. Institute of Technology, Bradford. Tues., 24 Mar., 6.45 p.m.
CHRISTCHURCH
"Application of Transistors to Line Communication Equipment," by H. T. Prior, D. J. R. Chapman and A. A. M. Whitehead. Southern Centre. King's Arms Hotel, Christchurch, Hants. Wed., 25 Mar., 6.30 p.m.*
EDINBURGH
Faraday Lecture on "Automation," by Dr. H. A. Thomas. South East Scotland Sub-centre. Usher Hall, Edinburgh. Tues., 24 Mar., 7 p.m.
FARNBOROUGH
"Space Research," by Dr. R. L. F. Boyd. Southern Centre. Technical College, Boundary Road, Farnborough. Tues., 24 Mar., 6 p.m.*
GLASGOW
"Thermonuclear Fusion and the Development of Zeta," by E. R. Hartill. South West Scotland Sub-centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Wed., 25 Mar., 7 p.m.
NEWCASTLE UPON TYNE
"Selection of Insulation Levels and Tests for High-Voltage Transformers," by G. B. Harper. North Eastern Centre. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 23 Mar., 6.15 p.m.

Institution of Engineering Designers

BRADFORD
"Machinery and Processes Involved in Carpet Making," by N. K. Earle. Yorkshire Branch. Midland Hotel, Bradford. Tues., 24 Mar., 7.30 p.m.

Institution of Engineering Inspection

GLASGOW
Discussion on "Argonaut and Argonarc Welding." West of Scotland Branch. St. Enoch Hotel, Glasgow. Wed., 25 Mar., 7.30 p.m.
WOLVERHAMPTON
"Manufacture and Inspection of Ball and Roller Bearings," by E. R. Walker. Wolverhampton Branch. Compton Grange, Compton Road, Wolverhampton. Mon., 23 Mar., 7.30 p.m.

Institution of Heating and Ventilating Engineers

GLASGOW
"Survey Methods of Pressurisation for Medium and High-Pressure Hot-Water Systems," by J. R. Kell. Scottish Branch. Scottish Building Centre, 425 Sauchiehall Street, Glasgow, C2. Tues., 31 Mar., 7 p.m.

Institution of Highway Engineers

NORWICH
Annual General Meeting and Film Display. East Anglia Branch. Assembly House, Theatre Street, Norwich. Wed., 1 April, 6.45 p.m.

Institution of Mechanical Engineers

LONDON
Open Discussion Meeting. Steam Group. Tues., 24 Mar., 6 p.m.*
Discussion on "Problems of Lubrication at High Temperatures." Lubrication Group. Wed., 25 Mar., 6 p.m.*
BEDFORD
"Management Control of Small Engineering Firms," by L. Fontaine, W. R. Spencer and J. W. Walker. Eastern Branch. Dujon Restaurant, Bedford. Tues., 24 Mar., 7.30 p.m.
CHESTER
"Design and Development of Four Light-Weight High-Speed Marine Gas Turbines," by A. W. Pope. North Western Branch. Blossoms Hotel, Chester. Tues., 24 Mar., 6.45 p.m.
DERBY
"The Petroleum Industry's Role in World Car Market Development," by K. E. W. Ridler. Derby A.D. Centre. Rolls-Royce Welfare Hall, Derby. Mon., 23 Mar., 6.15 p.m.
NOTTINGHAM
"Application of Electronic Techniques to Machine-Tool Control," H. A. Prime. East Midlands Branch. Engineering Building, The University, Nottingham. Wed., 25 Mar., 7.15 p.m.

Institution of Naval Architects

LONDON
Spring Meeting. "Some Thoughts on Dry Docks," by Lieut.-Col. T. Eustace Smith, at 10.15 a.m. Dinner, Grosvenor House, Park Lane, W1, at 7 for 7.30 p.m. Tues., 24 Mar.
"Train and Car Ferries," by J. P. Campbell; and "Cargo Container Ships," by D. A. Argyriadis, at 10.15 a.m. "An Analysis of Ship-Model Correlation Data Using the 1957 ITTC Line," by R. E. Clements; and "A Further Study of Ship Losses," by C. V. Manley, at 2.30 p.m. Wed., 25 Mar.
"Standard of Stability Adopted in Japan," by Dr. Eng. M. Yamagata; and "Tonnage Measurement," by Dr. Ing. L. Cristiani, at 10.15 a.m. Thurs., 26 Mar.

Institution of Plant Engineers

BLACKBURN
Annual General Meeting. Blackburn Branch. White Bull Hotel, Blackburn. Thurs., 26 Mar., 7.30 p.m.
BRISTOL
Annual General Meeting. Western Branch. Grand Hotel, Broad Street, Bristol. Tues., 24 Mar., 7.15 p.m.
LEEDS
Annual General Meeting. West and East Yorkshire Branch. Fuel Department, New Building, The University, Leeds. Mon., 23 Mar., 7.30 p.m.
SHEFFIELD
"Refractories," by T. R. Lynam. Sheffield Branch. Grand Hotel, Sheffield. Thurs., 26 Mar., 7.30 p.m.

Institution of Production Engineers

DERBY
Annual General Meeting and Film Evening. Derby Section. St. James's Restaurant, St. James's Street, Derby. Mon., 23 Mar., 7 p.m.
LIVERPOOL
Annual General Meeting and Film Evening. Liverpool Section. Exchange Hotel, Tithebarn Street, Liverpool 2. Tues., 24 Mar., 7.30 p.m.
MANCHESTER
Annual General Meeting. "Machining of Uranium, Thorium, Niobium, Vanadium, Zirconium and Beryllium," by A. Piggot. Manchester Section. Manchester College of Science and Technology, Sackville Street, Manchester. Tues., 24 Mar., 6.30 p.m.
WORCESTER
Annual General Meeting. "Numerical Control of Machine Tools," by O. S. Puckle. Worcester Section. Star Hotel, Worcester. Wed., 25 Mar., 7 p.m.

Institution of Structural Engineers

CARDIFF
"Plate-Girder Design," by Dr. K. C. Rockey. Wales and Monmouthshire Branch. South Wales Institute of Engineers, Park Place, Cardiff. Tues., 24 Mar., 6.30 p.m.

Manchester Statistical Society

MANCHESTER
"Recent Developments in the Measurement of Productivity in the Textile Industry," by L. H. C. Tippett. Industrial Group. Portico Restaurant, 57 Mosley Street, Manchester. Fri., 3 April, 6 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE UPON TYNE
"The Thermal and Elastic Properties of Eight Cast Irons," by Dr. D. Fitzgeorge and Professor J. A. Pope; and "An Investigation into the Creep Properties of Two Cast Irons," by C. Wheatley and Professor J. A. Pope. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 23 Mar., 6.15 p.m.

Reinforced Concrete Association

EDINBURGH
"Multi-Storey Flat Development in Birmingham," by J. R. Sheridan-Shedden. Scottish Branch. North British Hotel, Edinburgh. Tues., 24 Mar., 6.30 p.m.*

Royal Statistical Society

LEICESTER
Annual General Meeting. Answers to Members' Questions. Leicester Industrial Applications Group. Leicester College of Technology, The Newarke, Leicester. Thurs., 26 Mar., 7 p.m.

Sheffield Metallurgical Association

SHEFFIELD
Discussion on a methods of analysis subject. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 24 Mar., 7 p.m.

Society of Engineers

LONDON
"Sonics," by George Constantinesco. Geological Society, Burlington House, Piccadilly, W1. Mon., 6 April, 5.30 p.m.*

Society of Instrument Technology

LONDON
"New Directions in Engineering Psychology," by Dr. R. Conrad. Manson House, Portland Place, W1. Tues., 24 Mar., 6 p.m.*
CARDIFF
Annual General Meeting. "Instrumentation of a Nuclear Power Station," by K. R. Sandiford. South Wales Section. Welsh College of Advanced Technology, Cardiff. Wed., 25 Mar., 6.45 p.m.
CHESTER
"Industrial Applications of Transistors," by D. G. Holloway. Chester Section. Grosvenor Museum, Grosvenor Street, Chester. Wed., 25 Mar., 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this feature should reach the Editor not later than three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1. (LANgham 5927.)
British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901.)
Building Centre, 26 Store Street, London, WC1. (MUSeum 5400.)
Combustion Engineering Association, 6 Duke Street, St. James's, London, SW1. (WHItehall 5536.)
Engineers' Guild, 78 Buckingham Gate, London, SW1. (ABBey 7315.)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215.)
Institute of Metals, 17 Belgrave Square, London, SW1. (BELgravia 3291.)
Institute of Petroleum, 61 New Cavendish Street, London, W1. (LANgham 3583.)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847.)
Institution of Engineering Inspection, 28 Victoria Street, London, SW1. (ABBey 3794.)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158.)
Institution of Highway Engineers, 47 Victoria Street, London SW1. (ABBey 3891.)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476.)
Institution of Naval Architects, 10 Upper Belgrave Street, London, SW1. (SLOane 4622.)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469.)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254.)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128.)
Manchester Statistical Society: Industrial Group. Apply to Mr. T. J. Lunt, Ferranti Ltd., Hollingwood, Lancs.
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle upon Tyne 1. (Newcastle 20289.)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504.)
Royal Statistical Society, 21 Bentinck Street, London, W1. (WELbeck 7638.)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865.)
Society of Engineers, Abbey House, Victoria Street, London, SW1. (ABBey 7244.)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251.)

Leyland Sponsor Library

A library for employees, stocked with some 4,000 books (a quarter of them fiction) has been opened by Leyland Motors Limited at their day continuation school. The Lancashire County Council, as part of their scheme for the improvement of libraries in technical colleges, provided £1,200 for stocking it with books, and the company equipped a room at the school to house them.

Most of the non-fiction books are on subjects concerned with mechanical engineering but other subjects are included, ranging from bird watching to space travel. An annual sum of £100 has been allocated to maintain the stock, and new books will be added each year.

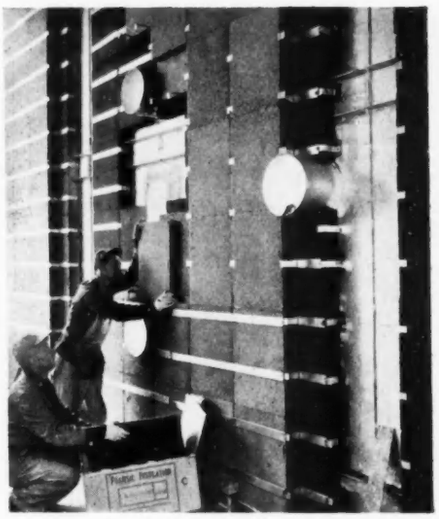
Metals and Materials

APPLICATIONS OF FOAMED GLASS

The small demand for cellular glass in this country has not justified installation of plant for its production. Such material is, however, made by Saint-Gobain, the French glass manufacturing company, who exhibited it as long ago as 1937 in Paris, and it has also been offered by firms behind the Iron Curtain, from Czechoslovakia. In America it is made by at least one firm, namely the Pittsburgh Corning Corporation. Brief mention of cellular glass was made in this journal on February 6, 1959, a product of Corning and incorporated in the company's pipe insulation "Stay-Dry." For such applications the manufacturers recommended a top working temperature of around 350° F. Further research work has enabled Corning to produce a foamed glass which has a higher silica content and correspondingly higher working temperatures, and this has been named "Foamsil." As with foamed glass, it is not an economic proposition to manufacture it in Great Britain, but as an insulation for use over a wide temperature range, which is impermeable by liquids and gases, it is of great interest. Where economically justified, demand may, of course, be satisfied by importation.

Coefficient of expansion	$3{\cdot}5 \times 10^{-6}$ per ° F
Compressive strength	130 to 210 lb per sq. in
Density	10 to 12 lb per cu. ft
Water absorption	No weight increase
Resistance to abrasion	Should be protected
Specific heat:	
100° F	0·120
500° F	0·235
900° F	0·265
1,200° F	0·277
Thermal conductivity:	
100° F	0·48 Btu per sq. ft per hr per °F per in
500° F	1·00 Btu per sq. ft per hr per °F per in
900° F	1·85 Btu per sq. ft per hr per °F per in
Thermal shock resistance	Excellent
Temperature limits	Cyclic — 450° F to 1,600° F; continuous 2,200° F

The new material, Foamsil, is 99 per cent pure fused silica and can neither oxidise nor absorb moisture. It is unaffected by all acids, with the exception of hydrofluoric and hot phosphoric. The material offers continuous insulating protection and withstands thermal shock within the range of −450° F to 2,200° F. The insulating value of 1 in of Foamsil is equivalent to that of 18 in of an acid brick at an operating temperature of 250° F. More complete property details are given in the table. Compared with a firebrick which can be used in the same temperature range, the main advantage is of course its lightness, at only 10 to 12 lb per cu. ft, but on top of this is the property of its impermeability, which arises from the fact that the bubbles in the silica are not interconnected. With the low expansion coefficient associated with pure silica, the foam is not only resistant to rapid changes in temperature, but reduces the need for expansion joints and vertical clearances when used as a fitted lining. In a furnace at 1,600° F, the material has suffered no deterioration even after two years.



Cellular glass and silica block insulation were particularly suited for use as lining material in this environmental test chamber for the aircraft industry.

The lack of demand in this country reflects the small number of applications for a material with such properties; indeed, it is seldom that the demands on a refractory are for high temperature resistance, lightness, impermeability, and acid resistance all at the same time. Those projected uses of the American product reflect the exploitation of only one or two properties, where there are alternative materials. The makers, for instance, see advantage in application as lining material for acid mixing tanks, and for chemical tanks of many types, for coke-ovens and for heat-treatment furnaces.

Undoubtedly, however, the cellular silica blocks are in some instances attractive, because of the ease with which they may be installed. Making use of this property, coupled with the material's ability to withstand thermal shock without spalling or cracking, Tennet Engineering of Union, New Jersey, USA, have just completed the world's largest environmental test chamber of its kind for the McDonnel Aircraft Corporation of St. Louis, Missouri, USA. The structure is described as a high-and-low temperature-altitude chamber, which is capable of maintaining temperatures ranging from − 100° F to 1,200° F, and of simulating altitude conditions up to 150,000 ft. In construction, the chamber consists of heavy steel plates welded to structural members. Next to this are two 2 in layers of Foamglas, the lower temperature cellular glass insulation referred to earlier. On the inside surface are two further layers, but of Foamsil. All joints are staggered, and the interior fittings are stainless steel. In such applications the foamed materials hold their own, but more must be found if manufacture in this country is to be economic.

FUNGICIDAL PAINT

"Mercian" mould-resistant and moisture-absorbent wallpaint is a waterbound chemical preparation for use on interior walls and ceilings in premises where mould growth and humidity are rife. It is applied with a soft brush or coarse-nozzled spray gun, and quickly provides a hard but porous coating which stays clean, dry and free from mould for long periods. In addition to its fungicidal qualities, it has the property of being able to absorb appreciable quantities of atmospheric moisture, thereby preventing excessive condensation and the associated unsightliness and unhealthiness of dripping walls and ceilings.

Although it is primarily a chemical preparation, its matt finish is thought by the makers to be adequately decorative for business premises. It is non-flammable, non-toxic and odourless. Re-application is said to be far simpler than with conventional paints—all that is necessary is to brush down the surface and paint it over again. Bad patches can easily be touched-up without complete re-painting. Mercian wallpaint is supplied ready to use in white or cream, in five-gallon pail-type containers with handles and detachable lids. Five gallons are sufficient for treatment of 200 square yards of wall or ceiling surfaces. Its suspension properties are said to be good.

Further particulars may be obtained from the selling agents—Farrow and Jackson Limited, 41-2 Prescot Street, London, E1.

RESIN-BONDED COATINGS OF PTFE

Acheson Colloids are now manufacturing and marketing a new range of resin-bonded dispersions of ptfe under the trade mark "Emralon." These dispersions represent an advance in the technique of dry film lubrication and surface coating. Ptfe is already well known as a lubricating solid with the following outstanding properties; extremely low coefficient of friction (only 0·04 under certain conditions); stability at high temperatures; resistance to chemical attack; and excellent parting properties.

At present two dispersons in the Emralon range are available; Emralon 810 (green), employing a phenolic binder, is applied by air spray and requires curing for one hour at 150° C. The coatings produced are tough, flexible, adhesive, non-soiling, corrosion resistant and have low friction characteristics. The dispersion can be applied to rubber, metal, plastics and other materials which will withstand the necessary bake. Emralon 820 (turquoise), which can be applied by spraying or dipping, contains a thermoplastic binder and needs no heat curing. Thus it is ideal for surfaces which are too sensitive even for the Emralon 810 low curing temperature, or for use where baking is impracticable. The turquoise coating will harden in air at room temperature in two hours. The friction coefficient of the film as applied will be between 0·05 and 0·07. For maximum corrosion resistance on ferrous substrates it is recommended that a phosphate pretreatment be employed. The coating can be used in contact with some weak solvents, but the use of strong solvents should be avoided because they will soften and destroy the film.

Trial packs of and further information on these dispersons can be obtained from Acheson Colloids Limited, P.O. Box No. 12, Prince Rock, Plymouth.

LARGER SHEETS OF TOUGHENED GLASS

Resulting from the development of a new toughening furnace with special heating element control, Pilkington Brothers are now able to produce toughened glass—"Armourplate," "Armourcast" and "Armourclad," in sizes up to 164 in by 60 in with thicknesses of $\frac{3}{8}$ in and $\frac{1}{4}$ in. These are probably the largest plates of toughened glass produced in the United Kingdom. In $\frac{1}{4}$ in thickness, the maximum sizes are 80 in by 54 in and 100 in by 36 in. An immediate advantage of the larger plates is the introduction of a larger size standard Armourplate glass door measuring 96 in by 36 in.

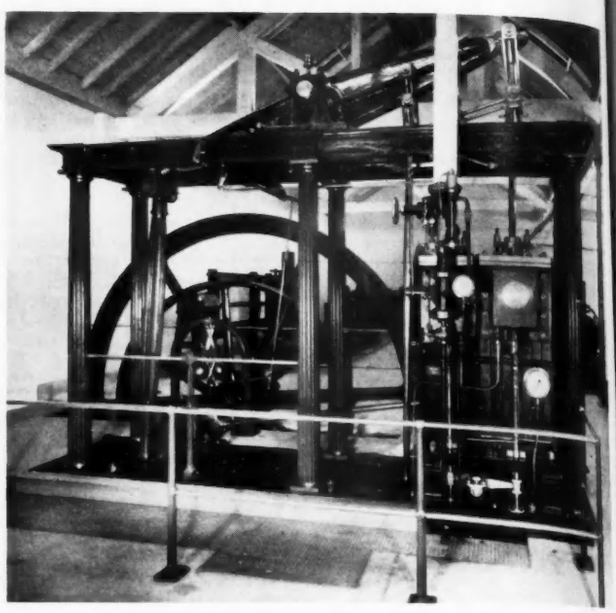
Orders for large size plates have already been met for glass clad buildings and protective windows in business premises and zoos. The company's works are at St. Helens, Lancashire.

Special Article

OLD ENGINES COME TO LIFE

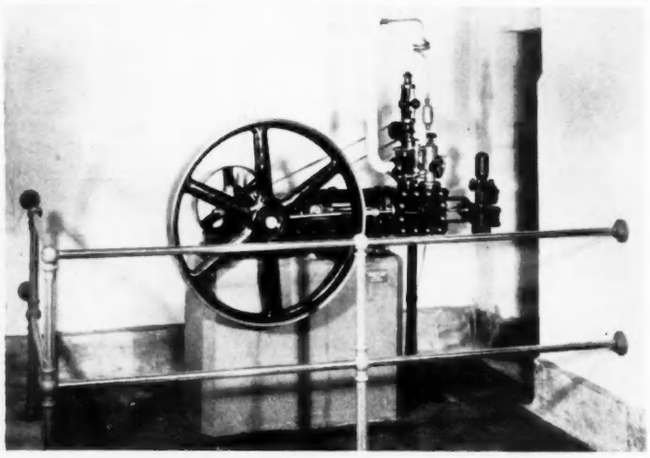
IN its eight years of existence Birmingham Museum of Science and Industry, Newall Street, Birmingham, 3, has done more than build up a fine collection of exhibits; it has developed an individual approach to the question of display. The underlying principle is that it is not enough to collect an item of interest, renovate it if necessary, put a label on it and invite the public to look at it. This might be satisfactory to the enthusiast in the particular field represented by the exhibit. He, by reason of his specialised knowledge, visualises the exhibit in its proper context. He knows what it did when it was in use, and he sees it, not as a static exhibit, complete but lifeless, but as something dynamic, doing, or at least ready to do, its normal work. In any case the enthusiast is probably too thankful that the exhibit has been preserved at all to worry about how it is displayed.

But in the public museum technically-minded enthusiasts represent only a small proportion of the total visitor potential. For the general public anything which can be done to increase the feeling of authenticity in an exhibit, in short, to put "life" into it, is all to the good. This principle has been taken to its logical conclusion in the latest section of the museum to be opened to the public—an extension to the engineering hall, where several steam engines can be seen at specified times actually running on steam—this being, as far as is known, the first live steam display to be opened to the public.



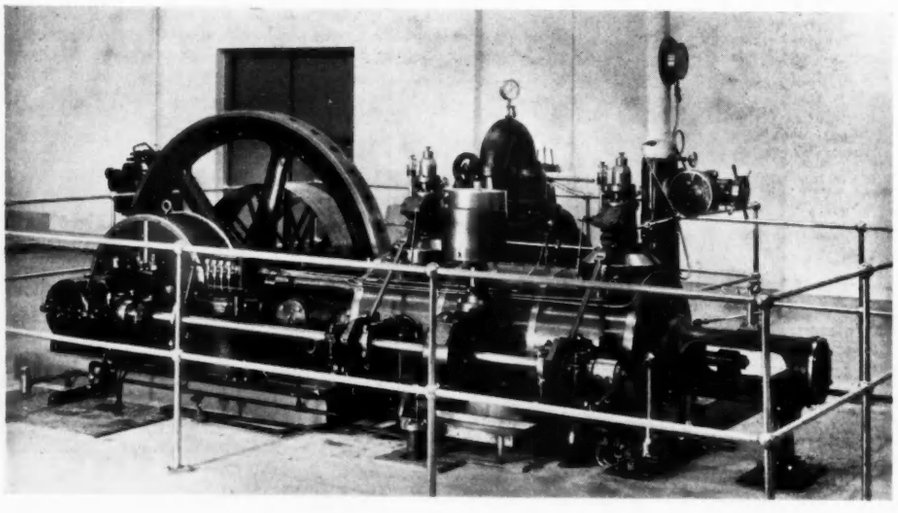
Oldest of the engines on show, this compound beam by Easton, Amos and Sons dates from 1860.

The engineering hall extension has a distinct Midland character, for besides steam engines, of which the Midlands are the real birthplace, there are numerous exhibits relating to trades for which Birmingham and some adjacent towns are famous. Screw making, for example, is well represented by heading, slotting and screwing machines, while other exhibits are typical of the allied trades of rivet, nail and pin making. Button manufacture, wire rope stranding, die casting, and holloware production are similarly represented by machines of various ages—in one case going back to *c.* 1860—and the machine tools exhibited include a Ward capstan lathe of 1912 and some larger items. A face plate lathe, capable of swinging 26 ft, and a wall planer, both from Soho Foundry, and dating from about the middle of the 19th century, are of particular interest. A large tilt hammer dating from the late 18th century, and used in a local edge tool works for many years, is an impressive centre-piece.



(Above) Thousands of simple little single-cylinder engines like this Tangye "Colonial" of 1891 were made; they are hard to find today.

(Below) This Galloway engine of 1924 is representative of a once numerous class — the uniflow type.



(Right) Steam hammers, like engines, were of many sizes. This Massey hammer is typical of the smaller ones.

LIVE STEAM

Some of the exhibits mentioned can be set in motion; all of them, and some others of which space does not permit mention, are complete and in working order. They constitute a valuable addition to the Museum's collection.

It is in the steam engine exhibits, however, that the novelty lies. In showing the engines " in steam " the Museum has broken new ground. One other engine—a little Savage fairground organ-blowing engine—has been shown to the public at frequent intervals in steam, but this was an isolated example and was, in any case, in the original section of the engineering hall at Birmingham Museum. The new display comprises three engines of different types, sizes and ages, and a steam hammer, all of which are shown working.

Steam is supplied from two coal-fired Ruston " Thermax " 8 ft by 12 ft boilers with Prior stokers working at 50 lb per sq. in, which have the primary duty of heating the Museum buildings. As the boilers are specifically intended for heating purposes and are installed at some distance from the engineering hall, they do not form part of the live steam display.

BEAM COMPOUND

The oldest of the engines on show is a compound beam engine built by Easton Amos and Sons in 1863 and used for driving machinery in a London gas works until recent years. It has a high-pressure cylinder 12½ in diameter by 25 in stroke and a low-pressure cylinder of 20 in by 36 in. Running at 32 r.p.m. on steam at about 40 lb per sq. in the engine is capable of giving about 30 i.h.p.

Next in chronological order is a B. and S. Massey overhung type 3 cwt steam hammer with the tup guided to make it suitable for die work if required; it can, of course, be used as a straight hammer equally well. This hammer, which dates from 1878, has a steam cylinder 7½ in diameter and 17 in stroke. It is controlled by Massey hand gear, giving full hand control or automatic stroking. The hammer is installed on proper foundations and has been tested with full normal blows in its present position. For display purposes, to prevent undue noise, it is short stroked under automatic control, so that the tup does not strike the anvil.

Representative of a very popular class of engine, the simple, robust general-purpose prime-mover of small size, is a Tangye " Colonial " horizontal engine of 1891. With a bore and stroke of 4½ in and 7 in respectively and a working pressure of 100 lb per sq. in, this engine would deliver about 6½ b.h.p. at 250 r.p.m. Many thousands of these engines were made, particularly, as the name indicates, for export, where their simple construction was an advantage and their ability to run for long periods without much attention a necessity.

The last of the present group of engines is of a more recent design and of more complicated construction. Built by Galloways Limited, Manchester, in 1924, the engine is a uniflow of 12½ in diameter and 26 in stroke. Running at 204 r.p.m. and the designed steam pressure of 120 lb per sq. in, the engine gave 63·6 i.h.p. It has oil-operated poppet inlet valves, the exhaust being, of course, through the ring of ports at the centre of the cylinder. Uniflow engines were usually of large size, and this small example, the work of a famous manufacturer of steam engines, was a fortunate acquisition for the Museum; it enables a once well-known and very successful type of engine to be shown in a reasonable space.

A FEELING OF REALITY

Steam machinery can be displayed in a museum in more than one way. It can be static—sometimes there are compelling reasons why it can never be otherwise, alternatively, an engine can be given a semblance of life by putting it in motion by compressed air or by a concealed electric drive. Sometimes the electric drive is not concealed. It may, on the contrary, be open to view as a deliberate act of policy; Birmingham Museum has a large Pollitt and Wigzell Corliss valve engine so driven. The Corliss motion is thus shown in action very clearly, and there can be no doubt in the mind of the public that the engine is being power-rotated deliberately. No one can harbour any suspicions of faking. All these methods of display serve a legitimate purpose, but there is no doubt that ultimately the proper way to show a steam engine is to bring it to " life " with steam, and that is what Birmingham Museum has done.

For the present the display is on a restricted scale. It is not practicable to run all the engines during the whole of the time the Museum is open. Instead, they will run at advertised times for stated periods. Neither will it be possible to have the live steam displays in the summer, when the heating boilers are not in use, though it is hoped eventually to do so.

That the experiment has succeeded there can be no doubt. The last word can remain with a member of the public who, on seeing the display, pointed out that although engines can be put in motion in various ways to give a semblance of life, nobody can fake the little wisp of steam escaping past the piston rod at the end of the stroke, or the smell of hot oil which every steam engine man will recognise. The Birmingham Museum engines have come to life.

Operation and Maintenance

FLEXIBLE CARGO VESSEL IN USE

What is believed to be the first commercial delivery of an oil cargo in a towed flexible vessel was made recently, when 10,000 gallons of kerosine were taken from the Fawley refinery of the Esso Petroleum Company Limited to the Esso oil depot at Newport, Isle of Wight.

A Dracone D1 vessel, 100 ft long and 5 ft diameter, of very strong nylon cloth coated with synthetic rubber, was used. This type of vessel, introduced by Dracone Developments Limited, 1 Tilney Street, London, W1, was described in ENGINEERING (3 Oct., '58, p. 440).

Towing, which was at a speed of 5 knots, was by means of a 45 h.p. launch, the time taken for the 10 mile journey being under two hours. Emptying at the destination was done with a self-contained pumping unit consisting of a Petter type PC2 diesel engine and a Goodyear size 12 pump, the cargo being pumped out in 65 min.

For the return journey the vessel was inflated instead of being reeled as in previous experimental voyages. On being emptied at Newport the Dracone was allowed to flatten and sink on the mud bottom of the harbour. It was then inflated with carbon dioxide supplied by the Distillers Company Limited, using Walter Kidde cylinders and equipment. Carbon dioxide was used to prevent any possibility of fire due to static electricity. The vessel was then towed back, the return journey, like the outward one, presenting no difficulties at all.

Although this first operation was carried out in daylight, provision was made for night travel if necessary by means of a tripod mounted tri-coloured acetylene lamp which the Dracone towed astern.

CONWAY RATED FOR SERVICE

The Rolls-Royce Conway by-pass turbojet has now been approved by the Air Registration Board of Great Britain at 18,000 lb minimum dry thrust for civil operation.

Deliveries of Conway engines to Boeing and Douglas began in October, 1958, for the 707-420 and DC-8 jet airliners, at a guaranteed minimum rating of 16,500 lb dry thrust which is the rating offered for initial Conways in airline service. The Air Registration Board and the Federal Aviation Agency of the United States have already approved this engine at 17,000 lb dry thrust.

After an initial period of experience, Conways in airline service can be uprated to 17,500 lb guaranteed minimum dry thrust by a minor adjustment to the external control system. Production deliveries will then be made at this rating. The approval now given by the Air Registration Board covers this second step of civil development for the Conway and the approval of the Federal Aviation Agency will shortly be sought.

THROW-AWAY AIR FILTER

Simpler and cheaper filter maintenance is achieved by the " Ozotex " low cost, throw-away air filter introduced by Ozonair Limited, The Esplanade, Rochester, Kent. The filters, which are light and easy to handle, can be fixed in a few seconds, trap dust over 5 microns in size in multiple air channels, the dust loading at twice initial resistance being 1 lb per sq. ft of surface area. Air resistance is low.

Curled fibrous elements bonded together and impregnated with an entirely new form of adhesive are used as the filter medium, and the special formation of the fibres ensures even air flow with freedom from packing. Air passes through in either direction with equal efficiency. Non-corrosive properties and complete freedom from disintegration and splintering are further features of the filtering medium.

The filters can be adapted to any size or shape and arranged in formation to suit the site. They can be arranged for either front or side withdrawal.

Production

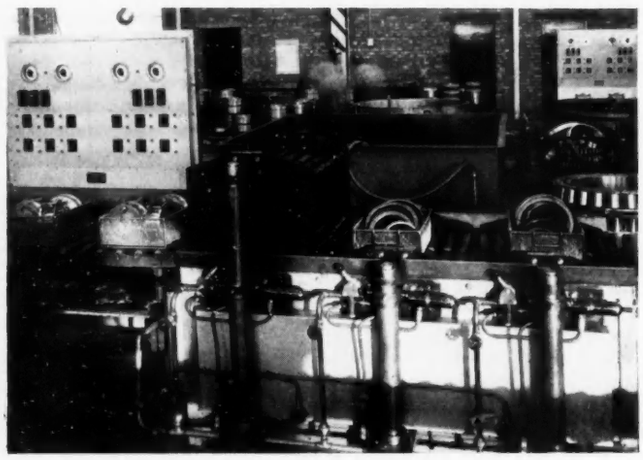
ELECTRIC SURFACE HEATING FOR GREASE TANKS

BRITISH Timken Limited, Durston, Northampton are using Isomantles, (electrically heated surface heaters made by Isopad Limited, Barnet Bypass, Borehamwood, Hertfordshire), for heating tanks employed for applying a grease coating to tapered roller bearings during their manufacture. The circular tank, seen in the foreground of the upper illustration, contains oil into which the bearings are dipped in the first instance in order to preheat them. The oil is warmed to a temperature of 190° F by Isomantles covering the side and base of the tank and giving a total loading of 18 kW. As soon as the bearings are brought up to that temperature, they are lifted into the second tank, containing the grease, which is maintained at the same temperature of 190° F by Isomantles of 14 kW loading.

Preheating and grease tanks heated by Isomantles at British Timken's Northampton works.

The control panel in the background provides coarse regulation of the 12 heating circuits in each tank by 3-heat switches and automatic control of the liquid temperature by mercury-in-steel thermometers, with a second thermometer of the same type governing the temperature of the heating surface.

The heating surfaces of the Isomantles comprise electric resistance elements attached to high-temperature glass cloth which is backed by 2½ in of thermal lagging and is covered by an outer metal shell carrying the junction boxes.



Automatically-controlled Isomantles regulate the temperature of the grease tanks in this mechanised grease-dipping plant at British Timken's works.

The lower illustration shows part of a similar arrangement using however, rectangular tanks. The tapered roller bearings arrive on a conveyor line and the dipping operation is carried out by a hydraulic device. The use of Isomantles ensures the efficient and fast application of a uniform grease coating to the bearings. The exact and automatic control of temperature has resulted in considerable savings in labour, material and power consumption. The grease can be used to the last drop, no charring occurs, and it appears that the overall saving has been such that the first installation paid for itself within a few months. Several other installations have now been put into operation.

KEEPING THE WORKER IN THE PICTURE

ANYTHING which will improve, and hold at the improved level, relationships between management and workers, should result in better production, and ought to be worth trying. The scheme operated by the Ministry of Labour and National Service, Training Within Industry for Supervisors, or more familiarly, "TWI," has been widely used, and has a good record of success. TWI was adopted by KLG Sparking Plugs Limited, Treforest, Glamorganshire, some two years ago. Various grades of KLG personnel were instructed in accordance with the Ministry programme, and when the training was finished it was generally agreed that all concerned had benefitted. It was also felt that something ought to be done to keep the spirit of the courses alive, and that unless this was done much of value was likely to be lost.

KLG management decided, therefore, to experiment with a follow-up procedure which would, or at any rate could, run indefinitely. In the event the follow-up has run for more than nine months, and shows no sign of losing its popularity, although participation is entirely voluntary, and takes place in the employees' own time.

Once a month, after working hours, a meeting is held in the firm's social centre for all grades of supervisory staff from senior machine setter to management. The meeting, which is preceded by tea, is under the chairmanship of the works manager, and is completely informal; no minutes or other written records of proceedings are kept. As already mentioned, attendance is voluntary, and no payment of any kind is made to those attending.

All meetings are opened by a few informal remarks from the works manager, who then invites anyone to speak on any subject concerning the day-to-day operation of the works. If no one comes forward, the works manager will start things moving himself, though it is rare that such an action is necessary.

It is not intended that the meeting shall be used as a forum for the ventilation of complaints. Having no executive power it is not the right place for such matters, and in any case, there is established machinery for the purpose which works successfully. On the other hand, the management has no intention of telling the workers what sort of questions they can ask—quite the reverse, in fact, no holds are barred. The function of the meeting has been defined as "Helping the workers to find out what makes the factory tick," and in this respect it works admirably.

Many things go on in a factory which the workers cannot help seeing but which may not appear to them to make sense. If they ask their immediate supervisor and he does not know, he is at least, through the meeting, in a position to find out. A common sort of question is "Why has a certain machine been moved, when it operated (or appeared to) just as well where it was?", or "Why is a new employee not given certain basic information?" Again, a section supervisor has asked, "Can the management show him how his section's work fits in to the general production picture?" Suggestions, comments, questions, all have their place at the meeting, and there is never a shortage of topics to discuss. In addition, it has now become the practice to show short 16 mm films of an appropriate type; some produced by the Central Office of Information, for example, have been well received and have provided the basis for discussion. They include "Introducing the New Worker" (15 min) and "The Supervisor as a Leader," Pts 1 and 2 (13 min each).

It is always difficult to evaluate an experiment of this nature. Factory output has increased during the period of the meetings, but the increase was planned and carried out by normal management methods and no part of it could be ascribed to the meetings. Nevertheless, there is ample evidence to show that the experiment is worth while. In the first place, average attendance, from the 50 or so eligible, is usually about 50 per cent. Of these, there is a hard core of about 10 to 15 who are regular attenders; the remainder come at no regular intervals, but turn up when they have something special to say. The regulars are obviously convinced of the value of the meetings—they could have no other reason for attending so regularly, since they can have no purely personal or financial gain. Clearly this must also apply to the others, who come from time to time; they must think it worth while.

When the meeting is in progress, there is nothing to stop members from leaving at any time if they wish, and sometimes a few do so, for special reasons, often connected with transport, but most stay on until the meeting is closed by the works manager.

From the management's point of view there has been a welcome decrease in the number of small irritating mistakes due to an operator not being fully aware of what he is supposed to do, and this improvement is clearly traceable to TWI, of which the discussion group is an essential part. Management have also been made aware, through the discussions, of some shortcomings in dealing with new employees, and arrangements have been put in hand to remedy the deficiency.

Construction

UNDERGROUND RAILWAY WORK IN LONDON

Easier Interchange of Passengers at Notting Hill Gate

THE new London Transport station at Notting Hill Gate, in West London, serving the Central and Circle lines, was brought into use on Sunday, March 1. It is the largest station reconstruction scheme to be undertaken by London Transport since the war. Built at a cost of £1,000,000, the new sub-surface station links the two lines by a joint ticket hall beneath the road and provides interchange by a subway at a lower level. Previously, the two million underground passengers who change from one line to the other every year have had to cross the busy main road of Notting Hill Gate on the surface.

Notting Hill Gate station is situated on one of the busiest routes into and out of London with an average of 32,000 vehicles a day passing along the road between the old Circle and Central Line station buildings, opened in 1868 and 1900 respectively. At this point, the width of the road was only 30 ft, forming a serious traffic bottleneck. Under a London County Council plan the road is being widened to 60 ft, and the station rebuilding scheme has been made to suit the LCC scheme.

The new facilities comprise the ticket hall (along with the pavement entrances on the south side of Notting Hill Gate), an interchange subway between the two lines, two main flights of escalators, and fixed stairs to the eastbound Central Line platform. A third and lowest flight of escalators will be brought into use in the late summer of 1960, and pavement entrances on the north side of Notting Hill Gate and the public subway beneath the road at the end of 1959.

PASSENGER ROUTINGS

The eastbound Central Line platform is 100 ft below the surface and the lifts travel down to 92 ft, short stairways leading from the lower landing down to the estabound and up to the westbound platforms. The westbound tunnel is partly above and to the side of the eastbound tunnel as the original builders were obliged to align both tunnels within the width of the street above.

The new ticket hall lies partly under the widened road and partly inside the new building line. The irregularly-shaped hall has a greatest length of 145 ft and a maximum width of 55 ft, but the average width is about 40 ft. Passengers will reach the ticket hall from the street by four stairways, two on each side of Notting Hill Gate. These entrances have temporary coverings at present, but will eventually be incorporated into the frontages of the new buildings. The two pavement entrances on the corners of Notting Hill Gate and Pembridge Gardens will give access to the ticket hall by a short subway.

From the ticket hall there is direct access by stairways to the Circle Line and by two flights of escalators to the westbound Central Line. A short stairway leads from the level of the westbound Central Line down to the eastbound Central Line, which is about 16 ft lower. The third flight of escalators will be installed, in addition to the staircase, as part of the final stage of the construction when the existing lifts have been removed. The two flights of escalators already installed include, in each case, a fixed stairway between the two machines which could be replaced by an additional escalator if required. The floor level of the ticket hall is approximately 12 ft below the surface and the top flight of escalators, having a drop of 31 ft, connects with the middle landing 43 ft below the surface. From this landing, an interchange subway 200 ft in length runs to two stairways which give access to the Circle Line platforms.

The original Circle Line station building has been demolished and work will start on the removal of the Central Line building when the lifts have been taken out of service. Use will be made of the two shafts to the Central Line for ventilation, which will be carried out by a pressure system operated by a fan in the disused stair shaft and a draft relief fairway through the lift shaft. The pressure system entails the construction of two tunnels connecting the lift shaft to the eastbound and westbound Central Line tunnels. These tunnels will be 240 ft and 170 ft in length respectively. A construction access tunnel linking two sections of the middle landing has also been retained as part of the pressure relief system.

The tunnels for the escalators, interchange subway and ventilation airways are almost entirely lined with cast iron segments. The two upper escalators are in 22 ft 9 in diameter tunnels, the chambers for the landings and machinery in 29 ft 6 in and 26 ft diameter tunnels, and the lowest escalators in a 23 ft 2½ in diameter tunnel. The interchange subway is in a 15 ft diameter tunnel and the ventilation tunnels are 6 ft in diameter.

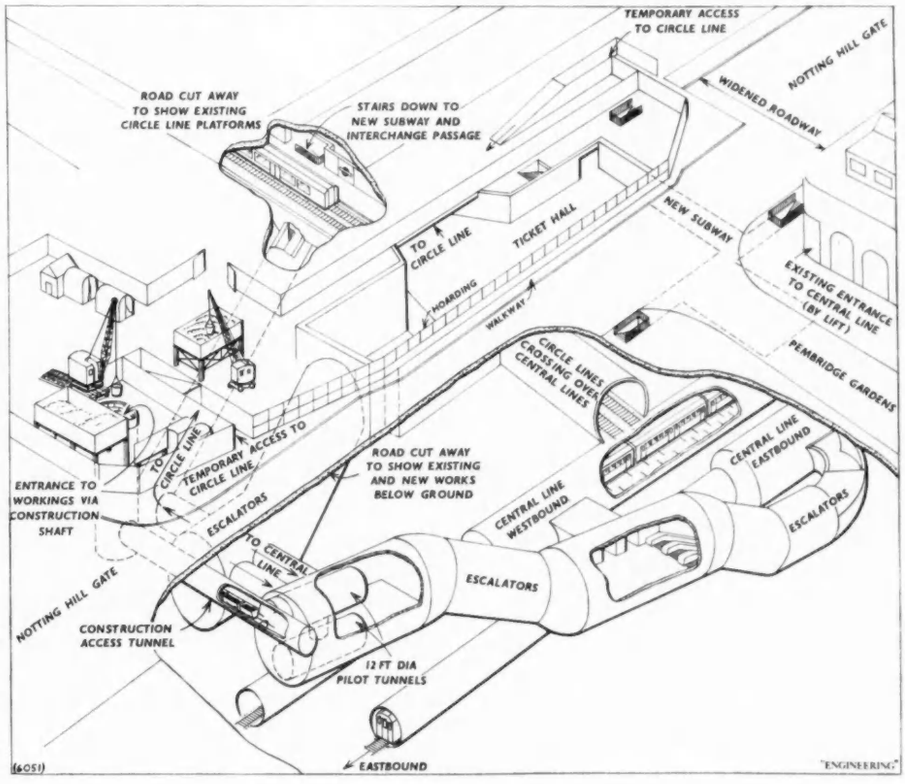
With the exception of part of the top escalator tunnel, all the tunnels are driven in the London blue clay which lies about 25 ft below the surface at this point. Above the clay is a sandy gravel in which the water level is about 5 ft above the clay and to avoid possible trouble when tunnelling through the gravel, it was chemically consolidated by the Joosten process in the vicinity of the top escalator. In all, about 17,500 cu. yd will have been excavated by the time the work is completed.

The booking hall, under part of which is the top escalator machine room, has mass concrete walls 4 ft thick and a similar floor 3 ft thick, the roof and floor acting as struts to the walls. The portion of the roof under the road is of steel-beam construction with concrete filling between, and is designed to carry the heaviest British Standard road loading. The part of the roof which will lie under the future buildings is of steel troughing covered in concrete, designed to carry a uniform floor loading of 100 lb per sq. ft. The main beams in this area will ultimately carry the weight of the future buildings to be erected above.

The most difficult engineering problem encountered was that of underpinning the walls, one over a length of 50 ft, of the Circle Line station to permit the construction of the interchange subway which passes beneath them. The two brick walls are 30 ft high and one of them supports five girders carrying a street over the railway. The interchange subway passes under the Circle Line tracks, which were supported on temporary beams to allow the subway to be built without interference to rail traffic.

Another problem was the construction of the ticket hall over the Circle Line tracks which are 27 ft below the street level in Notting Hill Gate, leaving restricted depth for the construction of the ticket hall. This was only made possible by demolishing the upper part of the brick arch over the railway tracks. To permit this to be done without interference to rail traffic a shield on steel ribs and designed to close tolerances had to be erected within the arch. Various services had to be diverted and re-aligned to allow the new subway to pass beneath them and the roof of the subway had to be carefully

Alterations at London Transport's Notting Hill Gate station to serve both the Circle and Central Lines.



Continuing

Construction

designed to keep the pipes as low as possible. Special measures also had to be adopted to avoid damage to existing tunnels. The tunnel for the middle flight of escalators passes close to the Central Line tunnels, approaching as near as 4 ft in two places. Additional timbering was employed at the working face and continuous working in three 8 hour shifts a day was adopted in this escalator tunnel.

All tunnels were driven in free air by hand using pneumatic spades. Except for the escalator tunnel already mentioned, tunnelling was carried out in two shifts every 24 hours, five days a week. Average progress per week was five rings (7 ft 6 in) in 29 ft 6 in diameter tunnels, five rings (6 ft) in 26 ft tunnels, and six rings (9 ft) in 22 ft 9 in tunnels.

The design of interior finishings is a complete departure from previous Underground station practice and precautions have been taken to prevent water seepage through ceilings and walls. The materials are chosen to give a contemporary look as well as to avoid expensive maintenance and walls are finished in high gloss tiles of contrasting shades. Barriers in the ticket hall are in aluminium and the ticket collectors' boxes are of aluminium framing with panels of plastics sheet and glass in harmony with the ticket office front.

The civil engineering work is being carried out to the requirements of Mr. C. E. Dunton, chief civil engineer, and the architectural work to the requirements of Mr. Thomas Bilbow, architect, London Transport. The consulting engineers are Mott, Hay and Anderson, of Westminster, London, SW1, and the civil engineering contract is let to Balfour Beatty and Company Limited. The building and finishing contract is being carried out by L. and W. Whitehead Limited. The road works in the area are the responsibility of the London County Council.

The escalator equipment is being supplied to the requirements of Mr. A. W. Manser, chief mechanical engineer (railways), London Transport, by the Otis Elevator Company.

MAINTENANCE COSTS *of* CONCRETE BRIDGES

The durability of concrete structures on the Danish State Railways is the subject of a report just issued by the National Institute of Building Research and the Academy of Technical Sciences.* The report deals in detail with the inspection and maintenance of such structures over the last 30 years. Emphasis is laid on the description of damage to the concrete and, where the information is available, an indication is given of the cause of the damage. Special mention is made of the maintenance work carried out on the Oddesund bridge where harmful alkali reactions have caused trouble.

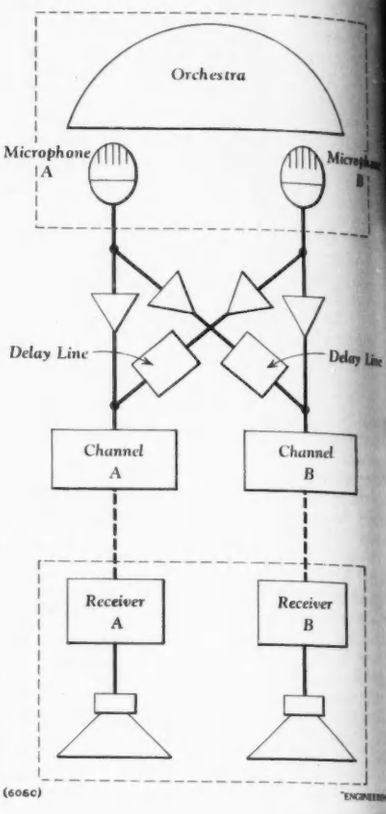
The report also contains a review of the methods which have been adopted for the maintenance of all types of concrete bridges. The last section of the report contains a comparison of the costs for the construction and maintenance of the various types of concrete bridges built for the State Railway during the first half of this century.

* "Durability and Maintenance of Concrete Structures on Danish Railways," by Arne Jeppesen. Progress Report, Series B—No. 3, by the Committee on Alkali Reactions in Concrete. Their address is care of the SBI, 20 Borgergade, Copenhagen K. No price is given.

Engineering at Home

STEREOPHONIC BROADCASTING

Now Compatible with Single Channel Reception



SINCE the BBC began their now regular broadcasts of stereophonic sound programmes last May, interest among listeners has risen very considerably and enthusiasts are keen to have more programmes made available. However, the major obstacle to the increased output of these programmes has been the unfairness to the listener with only one receiver. If a broadcast is made with the full stereophonic effect the sound heard by the single channel listener comes from only one of two widely spaced microphones and misses some part of the original sounds. His reception is poorly balanced because the microphone placing is arranged for the stereo listener.

A new "compatibility" circuit which has been developed by the Bell Telephone Laboratories, New York, USA, can now be used to eliminate this problem. By use of this circuit at the transmitter, the single channel listener can receive a stereophonic broadcast at the same quality level as a normal single channel broadcast.

The circuit depends for its success on a psychoacoustic phenomenon known as the "precedence effect." This effect operates in such a manner that when a single sound is reproduced through two separate loudspeakers, but is delayed by several milliseconds in one, the listener will hear the sound as if it came only from the speaker which he heard first. He will judge the other speaker to be silent. The amount of the precedence effect depends somewhat on the length of the delay; at 10 milliseconds, the sense of direction of the average observer is as if the echo were 8 to 10 decibels softer than the sound preceding it.

In this new development, the circuits between the microphones and their corresponding transmitters are cross connected through two delay lines, each with its own buffer amplifier. Because of the cross connections, signals from the left microphone are transmitted directly to the left loudspeaker in the listener's home, while the same signal is slightly delayed before reaching the speaker to his right. The stereo listener will hear the sound as if it came only from his left loudspeaker because of the precedence effect. Conversely, the sound from the right microphone goes direct to the right loudspeaker, but is delayed before reaching the left speaker and is therefore unheard there. Thus the brain of the listener localises the sound he hears as coming directly from each of his two speakers, and the full stereophonic effect is maintained for the listener with the requisite receivers.

However, monophonic reception is completely compatible with this, since a listener to either single channel hears the total sound from both microphones in a balanced reproduction. The slight delay built in apparently does not affect his reception, according to subjective tests made at the Bell Laboratories, where a 10 millisecond delay was used.

This development can enable more frequent broadcasts to be made and at the same time it will eliminate the need to dilute the stereophonic effect in order to achieve a compromise of compatibility.

HORIZONTAL AERIALS IN THE WEST COUNTRY

VHF Transmissions from Wenvoe

The new high-power VHF transmitter which has been installed at Wenvoe, South Wales, by the BBC to broadcast the Third Programme and Network Three, came into service on 1 March. Listeners with VHF receivers and suitable aerials should obtain greatly improved reception from the new transmitter. VHF is much less susceptible than medium waves to interference from foreign stations and from electrical apparatus, and is capable of much better reproduction. The new transmissions like those already being broadcast from Wenvoe, are horizontally polarised, so that aerials must be positioned horizontally to obtain the best results.

ENGINEERING

Published every Friday by ENGINEERING LTD. at 36 Bedford Street, London, W.C.2.
Telephone: Temple Bar 3663.
Telegrams: Engineering Lesquare London.

CHAIRMAN: J. A. Dixon, M.A., A.M.I.Mech.E.
EDITOR: F. B. Roberts, M.B.E., M.I.Mech.E., A.M.I.Loco.E.
DEPUTY EDITORS: D. Fisher, Ph.D., B.Sc., A.M.I.C.E., A.M.I.Mech.E.; E. P. Ward, M.A., A.M.I.Mech.E.
ASSISTANT EDITORS: J. E. Dodsworth; W. K. V. Gale, M.I.S.I.; J. T. Godfrey; M. Neal, B.Sc., D.I.C., A.F.R.Ae.S.; A. A. H. Scott, B.Sc., A.M.I.Mech.E.
SUBSCRIPTION MANAGER: G. A. Roberts.
ADVERTISEMENT MANAGER: G. H. Dixon.

Annual subscription rates: Inland and abroad £5 10*s* (Canada, £5 5*s*). Three months, 27*s* 6*d* all countries. Single copies, 2*s* 7*d* post free.

Engineering Information Service: Assistance is available from Engineering Information Service in obtaining information, and in locating sources of information, both technical and commercial. EIS deals, for example with names of makers and suppliers of plant and equipment, technical data on design, markets for engineering products, and compilation of references to information on specific topics. Inquiries should be addressed to Engineering Information Service at the address given in the left-hand column.